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ABSTRACT

The second of two volumes in these proceedings contains the text (or, in some cases, an abstract) of 124 papers on the use of technology at all levels of education, including elementary, secondary, and higher education. These papers were presented at 25 topic sessions by delegates representing more than 30 nations. Themes of the sessions include: (1) educational administration and leadership; (2) enabling technologies; (3) higher education; (4) computers to enhance instruction; (5) artificial intelligence; (6) open and distance learning; (7) teacher education; (8) futures; and (9) software compatibility. Forty-one presentations from or descriptions of poster sessions are also included, and an alphabetical list of authors in this volume is provided. (GL)

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The Sixth International Conference on Technology and Education

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Volume 2

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Orlando, Florida – March 1989

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LOAVES AND FISHES: 600 STUDENTS, 7 COMPUTERS

Debby Garrett Reed *

ABSTRACT

How does one manage just seven computers with six hundred children? This presentation shows how one rural Georgia primary school has coped. Though no formal research has been conducted, the teachers at Wrightsville Primary School (WPS) agree that the overall effect of their teaching has been enhanced greatly by the use of microcomputers in their classrooms. Student motivation has improved; computers are being used as a reward to promote better discipline; and though computers cannot take all the credit, test scores are improving.

INTRODUCTION

In October of 1982, as part of a Staff Development program, a course entitled "Microcomputers in the Classroom" was offered to the teachers at WPS. Approximately half a dozen of our forty teachers took the class. The main theme of the class was programming. All but one of the students from WPS left the class vowing never to look at another microcomputer.

The one who was not intimidated by the "everything you need to know about programming in one night" approach of the instructor-- instead of giving up on computers, bought one to work with at home. After two months of "playing" at home, this computer moved to the classroom and thus began the computer education program at Wrightsville Primary School.

This first computer was mine. At the time I was teaching third grade Chapter I students in Language Arts and Math.
As my interest and that of my students grew, I began to ask about funding for school-owned computer equipment. The more I learned, the more I wanted to share this new exciting teaching tool. I asked for permission to write a curriculum guide for grades K-4 in Computer Education. I was turned down for funding the equipment and for writing the curriculum guide. It was the opinion of my principal that even if computer education did become an important issue with the State Department of Education, they would never implement a program or offer any funding at the primary level. At this point (1983), I purchased another computer for my classroom and continued to try and convince other colleagues of the importance of introducing technology to our students at WPS.

*Third Grade Teacher, Computer Coordinator, Wrightsville Primary School, Johnson County Public Schools, Wrightsville , Georgia.

FUNDING PROGRESS

In 1984 Johnson County School System received a technology grant from the Georgia State Department of Education. The monies were then divided equally between the four schools in the system. The grant stipulated that the money must be spent on computers. WPS purchased two computers with their share of the grant. At that time our enrollment was approximately 480. As our school is divided into two wings, it was decided that one computer would be placed in each wing on a media cart to be rolled in and out of classrooms as needed.

The technology grant was continued the next year with the stipulation that the money could only be used for software. With this money our software library was expanded to ten programs in Language Arts and Math. Chapter II funds came through for two more computers. These were placed in our basement rooms to avoid unnecessary movement up and down stairs.

In 1986, the technology grant stipulated that only computers for administrative use could be purchased. One computer was purchased to be housed in the Media Center for teachers' and administrators' use only. The County Board of Education joined the state Software Consortium which netted WPS an additional one hundred programs in Math, Science, Social Studies, Music, Art, and Language Arts.

In 1987, Chapter II funds purchased two more computers and school funds began to cover the cost of additional software. We also continued to receive new programs from the consortium.

This year, no funds have been made available from the technology grant program or Chapter II as of yet.
Software programs continue to be added as the school has funds and teachers are using part of their supply money to purchase programs as well. Teachers also add to the school's software library by purchasing programs from Public Domain resources at very minimal costs.

TRAINING A "COMPUTER ILLITERATE" STAFF

As I began using the computer more and more in my classroom and word spread among the students, several of my colleagues began asking questions about the computers so that by the time the first school-owned computers arrived, there was a need for some type of group training. It was decided that another Staff Development (SDU) course on computers would be offered. We did learn from our first mistakes, and this time hired a person who could teach our teachers how to use the computer without scaring them with all the technical terms of programming. This program was a huge success.

The program was offered in 1986 and has been repeated for new teachers to the system each year. Before 1986, the computers were used by only a handful of teachers and the same programs were used repeatedly. Since the SDU course, computer schedules are full and all the software is being used. This year as part of our activities during Computer Learning Month in October, we held a computer fair for students and parents. Each teacher in the school tried three new software programs they had never used before to enable our school to become a Computer Learning Month Certified School.

Training of our staff continues as new ideas are shared and new programs are purchased. A group of teachers came to me and wanted to know about how I use a spreadsheet program to keep all my grades. I am now teaching a class for teachers two days a week on setting up grading programs, using print-shop type programs, writing drill programs, and word processing.

HOUSING/MAINTAINANCE

Our enrollment is now near six hundred. There are twelve computers in our school, seven of which may be checked out by teachers for use in their classrooms. Three computers are permanently housed in Kindergarten because they were purchased through a special program grant for at-risk students in Kindergarten. At-risk students were also targeted with special program grants in our Chapter II classes. There are two computers which must remain in the Chapter II classrooms. The others are divided one per grade (K-4), one in the Media Center and one in my classroom. The school owns one printer which is also housed in the Media Center to be checked out as needed. All software (which now numbers over 200 programs) is housed in the Media Center.

Our District Resource office (CESA) provides some maintainance, but we do most of it ourselves. As part of my training to be Computer Education Coordinator, I attended a workshop on computer maintainance. This cuts down on our costs considerably. All minor repairs (changing fuses, replacing blown chips, regulating disk drives, cleaning of all components, cable repairs) are done at school without the need for or expense of a technician.

SCHEDULING

Computers are checked out on a first-come-first-serve basis by way of a sign-up sheet in each grade. Teachers may check out computers and software for a maximum of two weeks at a time and must give the grade coordinator at least two days notice of when the computer is needed.

Scheduling within the classroom is up to each individual teacher. In my classroom, I use a variety of methods. For a special unit, I may assign a time for each child. When using the computer as a reinforcement tool, I simply turn it on at 8:05 and turn it off at 3:30 ; and students may use the computer anytime during the day when they have free time. Also to reinforce certain skills for the remedial student, I may assign a computer task for him/her while the rest of the class works on another task with me. I also use the computer to teach skills to the entire class by means of a projection device.

Students also use the computers during recess times. Coupons are issued to students with outstanding discipline records for a "computer recess" and may be redeemed in any classroom where a computer is being housed.

CONCLUSION

It is hoped that as we share the things we have accomplished at WPS with other small schools in our state and surrounding states, these schools will realize that they too can have a successful computer education program without the million-dollar programs of the bigger school systems.

It is not the number of computers or software programs the computer education program possesses which determines the success of the program, but rather the ways in which the available resources are put to use.

Many small schools beginning computer education programs have put computers aside to wait until their program is fully funded for a computer in every classroom or until a lab situation is fully implemented. It is hoped that through our example we can show others how to build a successful program by using the resources available to them now and expanding as their program is allowed to grow.

PSYCHE TRIVIA - A COMPUTER GAME DESIGNED TO AUGMENT PSYCHOLOGY CLASSES

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ABSTRACT

A case study of students and their participation in a computer-based game -- "Psyche Trivia." Students were provided an opportunity to use the message feature (E-Mail) of a mainframe computer as a voluntary augmentation of their Introductory Psychology course. Student E-Mail subscribers were assigned user identification codes at the beginning of the quarter, and through a series of help menus, were guided in both the use of the computer and the game-playing "how-tos." It is noted that fully eighty-five percent of the first-year students of the community college in question were computer neophytes, having none or very limited experience with the technology. By the second week of the quarter, ninety-five percent of the instructor's "intro students" had accessed the system and were actively participating in Psyche Trivia. In addition to playing the game, students were also able to use E-Mail to exchange messages with the instructor -- telectronic office hours! While students thought Psyche Trivia "fun" (prizes and certificates were awarded), additional outcomes became apparent. End-of-the-course evaluations overwhelmingly endorsed the idea of a computer augmented Introduction to Psychology.

INTRODUCTION

What is Arachibutynophobia? What are Zener Cards used for? What was Freud's father's name? Who was the basketball player who co-authored The Memory Book? These are typical of the questions I ask my Introductory Psychology students who play "Psyche Trivia." Each quarter, I give my students an opportunity to establish an electronic computer mailbox (E-Mail). Students who choose to do so may then use the message feature of the E-Mail system and/or play Psyche Trivia.

My motivation in designing and producing Psyche Trivia was in response to three assumptions: (1) Most actual learning takes place outside of the classroom, and Psyche Trivia is a mechanism for keeping students actively engaged when not in class; (2) Learning, at least initially, should be an affective experience (exciting). In other words, if a student is exposed and involved with educational experiences that are interesting and meaningful, then the principles/concepts are "easy," and (3) Computers are/will be an integral part of all student's formal education, given some community college student naivete and, indeed for some, cyberphobia, Psyche Trivia may provide a "first" casual non-threatening exposure to the technology.

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These "assumptions" became the basis and justification for playing the game - Psyche Trivia. Interestingly, and as so often is the case, unanticipated positive outcomes emerged from the reality of over four years of playing Psyche Trivia. But first, a brief description of the procedures involved in the design and implementation of the game.

THE GAME - PSYCHE TRIVIA

Student E-mail subscribers are assigned user identification codes at the beginning of the quarter. The technology of the system enables messages (questions) to be entered into the college's mainframe computer and then held until the recipients access their electronic mailbox via one of the CRT terminals located throughout the campus. Once the student accesses the system, the computer, through a series of help menus, guides the user through the process of entering, sending and receiving messages. I mail a Psyche Trivia question once a day to all students, they in turn, have 24 hours to answer the question to my userid. Each 24 hours, I answer the previous Psyche Trivia question and post the next days question. A correct answer earns students a "psyche point" which, as an inducement/reward to play, may lead to winning a prize, e.g. 1st place - a year's subscription to the magazine Psychology Today; 2nd place - a VIP Meal Certificate from the on-campus restaurant; 3rd place - a gold embossed College Certificate of Participation. The game begins the second week and ends the ninth week of the quarter with a total of 35 Psyche Trivia questions having been "played."

In making-up the questions for the game, I endeavored to do two things: make the questions fun and relevant to the lecture/text subject matter. In other words, when the topic of Perception/Sensation was being covered, I might ask the trivia question, "What is the only animal that cannot sense the taste of 'sweetness'?" (Answer: Cat). For the unit on Learning, I might ask the question: "What animal did B. F. Skinner's propose as a missile pilot?" (Answer: Pigeon). I have a bank of over 200 psyche trivia questions, enabling me to vary questions from quarter to quarter. In a few instances, students volunteer questions by asking me one they had thought up. One of the better student originated questions was: "What Freudian personality structure corresponds to Dr. Jykell (Jykell and Hyde fame)?" (Answer: Id)

ASSESSMENT

Approximately ninety-five percent of the students in my introductory classes access the E-Mail system and, of those, nearly seventy percent played the game for the duration. End-of-the-quarter surveys have consistently and overwhelmingly resulted in favorable comments, e.g. "...a fun part of the course;" "...an extra dimension to the world of psychology;" "...got me to the library;" "...thanks for the game...". Indeed, Computer Lab Aides and Reference Librarians who encountered students frequently commented on the interest generated by the game. In addition, students who won prizes wrote personal "thank you" notes to the instructor reflecting on both the enjoyment and opportunities derived from Psyche Trivia. And the most mentioned "opportunity" was the students' first hands-on experience with a computer!

As was noted earlier, a number of unanticipated outcomes occurred as a result of "the game." Such outcomes included the following:

- Students and the instructor enjoyed an additional mechanism/avenue for establishing rapport. Indeed, students used E-Mail for the exchange of messages that had nothing to do with Psyche Trivia. Most students in lecture-discussion based classes rarely communicate directly/privately with the instructor. Consequentially students used the game for what essentially became electronic office hours! I would spend from one to two hours a day responding to questions/discussion topics that ranged from course management through general interests, to "personal problems" - it is the nature of a first psychology course. But the surprising thing about E-Mail was the sheer number of questions generated. Sometimes the "problem" could be resolved by my return answer, and sometimes I would invite the student to the office for further discussion. In either case, the computer actually seemed to overcome the barriers to faculty-student exchanges.

- Many students interacted with each other outside the classroom on matters germane to psychology - developing a subject-based rapport not usually available within the typical structure of an introductory course.

- An opportunity existed for students to gain some small measure of success and/or positive reinforcement aside from "good grades."

- Some few students who became rather proficient on the computer were offered jobs by the college as lab-aides. Also, and relatedly, a number of students, as a direct result of Psychology, signed-up for the college's Introductory Computer Course!

CONCLUSION

In conclusion, my students clearly valued a computer-augmented psychology class. And, interestingly, a number of students thought their academic grade was enhanced by playing Psyche Trivia. Their reasons given included: 1) heightened motivation for the material; (2) greater commitment to the course - they didn't want to miss a day's question?; and 3) the study groups that evolved from the rapport of playing the game. Indeed a tentative relationship between Psyche Trivia and enhanced academic course grades was observed. A matched sample of students who played the game was compared with students who did not play. Those students who played Psyche Trivia achieved significantly higher test scores and course grades. However, such a casual relationship as per enhanced course grades, must await further research.

Computer Software Used in Secondary School Courses

Al Monetta*

ABSTRACT

The goal of Waterford Schools (near Pontiac, Michigan) is to use technology where appropriate to enhance instruction and to provide for maximum student learning by integrating the use of instructional technologies within the current curriculum. The five secondary schools service students in grades 7-12 and students use Tandy/Radio Shack Model I's, Model III's & 4's, and Tandy 1000's. A list of all software that is being used for grades 7-12 is organized by department and course; the software has a notation of publisher and of grade level at which it is currently used.

INSTRUCTIONAL SOFTWARE LISTING

Social Studies
  Economics:
    The Whatsit Corporation
    9-12 Sunburst

  Geography:
    Where in the World/USA/Europe is Carmen Sandiego?™
    8-12 Broderbund
    GeoWorld, A Living Database
    7-12 Tom Snyder Productions
    National Inspirer
    7-12 Tom Snyder Productions

  History:
    pfs:file with Scholastic American History data base
    11 Scholastic
    Decisions, Decisions: Colonization, On Campaign Trail
    7-12 Tom Snyder Productions
    TimeLiner
    7-12 Tom Snyder Productions
    The Ripple That Changed American History
    7-12 Tom Snyder Productions

  Sociology:
    Decisions, Decisions: Television Ethics
    7-12 Tom Snyder Productions

  Research:
    Grolier's Encyclopedia on CD-ROM
    7-12 Grolier's

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Mathematics
General Math:
The Math Shop$^{\text{TIME}}$
7-9 Scholastic
Managing Lifestyles
9-12 Sunburst
Success with Mathematics
7-9 CBS Software

Geometry:
The Geometric Supposer: Triangles$^{\text{TIME}}$
9-12 Sunburst
The Factory$^{\text{TIME}}$
7-9 Sunburst
PC Logo
7-12 Harvard Associates

Algebra:
True BASIC Algebra I & Algebra II
8-12 True BASIC (Chambers International Corp)
Green Globs and Graphing Equations$^{\text{TIME}}$
9-12 Sunburst
The Algebra Shop
8-12 Scholastic

Electronics
Rocky's Boots
10-11 The Learning Company

Science
Physical Science :
The Geology Search$^{\text{TIME}}$
8-10 Webster Division, McGraw Hill Book Company
GeoWorld, A Living Database
7-12 Tom Snyder Productions

Health:
Cardio-Vascular Lab$^{\text{TIME}}$
8-9 Broderbund

Physics:
Science Toolkit, Module I: Speed & Motion$^{\text{TIME}}$
9-12 Broderbund

Instrumental Music
Music Term-inator, Tune-Up!, and Woodwind Teachers Assistant
7-9 Swan Software

Art
PC PaintBrush
10-12 Z-Soft Corporation
Computer Eyes
7-12 Scholastic

Drafting
    AutoSketch
    7-9 AutoCAD
    AutoCAD
    10-12 AutoCAD

Counseling
    Discover program
    10-12 ACT, Inc
    The Resume
    10-12 Education Associates, Inc
    Mastering the SAT and Mastering the ACT
    10-12 CBS Software
    Peterson's College Selection Service
    Peterson's Financial Aid Service
    10-12

Computer Applications
    The Newsroom[TIME]
    9-12 Scholastic version
    Print Master[TIME]
    7-12 Unison World, Inc
    Crossword Magic
    7-12 Mindscape Educational Software
    VidKit II, MS-DOS Authoring Software for Laserdisc interface
    7-12 VideoDiscovery

Language Arts
    Textra, a word processor
    7-12 Ann Arbor Software

SOME RESOURCES:

Appell, Louise, editor, *Using Grolier's Productivity Software Across the Curriculum*, Grolier Electronic Publishing, Inc, (1986); lesson plans for mathematics, language arts, science, special education, social studies, library science using spreadsheet and database programs.

Dockterman, David and Tom Synder, *How to Incorporate the Computer into the Social Studies Classroom*, Tom Synder Productions, Inc, (1986). A brochure for teachers with ideas for using a computer and evaluating computer software for social studies.

Parson, Gail, *Hand in Hand: The Writing Process and The Microcomputer*, Alaska Department of Education, (1985). Case histories of teachers who are using word processing to teach writing in secondary schools. Chapters on the writing process, word processing hardware and software, training teachers and students, and use in the classroom.

[TIME] These software items have teacher materials and lesson plan ideas available from the Technology in Michigan Education Grant; the teacher materials are available through Oakland Schools, 2100 Pontiac Lake Road, Pontiac, MI 48054 ATTN: Lynn Lieberman

UTILITY SYSTEM TO GENERATE CRITERION-REFERENCED MEASUREMENTS WITH AN OPTIMAL CUTTING SCORE

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ABSTRACT

A utility system is described for a simple computing configuration so that formative evaluation based on tests and referred to different criteria can be implemented. Those tests have been empirically determined for an optimal cutting score.

The designed utility system is able to:

- *Organize a bank of items*
- *Organize tests*
- *Fix the optimal cutting score*
- *Keep a formative evaluation system referred to criteria that are accessible to students.*

INTRODUCTION

Developing countries cannot evade microcomputer's incorporation into primary and secondary educational levels. Budget limitations frequently restrain any kind of efforts made by the educational community. Schools financially dependent on the State present even more acute problems in relation to budgets. Every time they receive any kind of donation or financing, these schools just receive little number of computing configurations, with little memory capacity and simple peripherals to be used by teachers in their activity of teaching, control of learning and instructional design and, also, by students in their learning activities.

All the conditions previously shown need to be carefully considered in case any kind of software, with a wide range of application, is to be developed.

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SYSTEM CHARACTERISTICS

This work is schemed within these criteria due to it describes a utility system design for a simple computing configuration widely used in Chilean educational centers. The developed system is able to:

1) Organize banks of items for specific learning objetives.
2) Design evaluation tests based on the mentioned objetives.
3) Validate these tests in relation to the discriminating capacity among those who dominate and those who effectively do not all the abilities expressed in the objetive.
4) Obtain statistical index to assign the minimun acceptable efficiency pattern.
5) Generate tests to be used by students in the process of formative evaluation of their own learning.

OPTIMAL CUTTING SCORE ASSIGNMENT

The method proposed by Berk A.R. (Ref.1) has been incorporated to the system we have developed. This method enables us to fix empirically the optimal cutting score of a test among those who dominate and those who do not dominate a stablished behaviour in a learning specific objetive.

To determine the optimal cutting score, a test with a group of items directly linked to an objetive should be made and obtain the result of its application in two different student groups. One of the groups should be constituted by those students who do not dominate the stablished behaviour because they have not developed learning activities related to it so far; and the other, by students who really dominate the mentioned behaviour.

Score distribution of both groups in a chart shows four different categories when we fix a cutting score in the two curves meeting point.

The four categories are formed by students that:

A. Effectively dominate the behaviour and pass the cutting score.
B. Effectively dominate the behaviour but do not pass the cutting score.
C. Do not dominate the behaviour and pass the cutting score.
D. Do not dominate the behaviour and do not pass the cutting score.

Errors are made by accepting the conditions stablished in B and C since students who effectively dominate the behaviour fail (Type I Error) and some students who do not dominate the behaviour pass (Type II Error).

The optimal cutting score is located where Type I and Type II errors have a minimun value. The method proposed by Berk estimates a series of index that permit the more adequate cutting score choice for any test characteristics.

UTILITY SYSTEM DESCRIPTION

The utility system has been designed based on a Main Menu offering the following options:

1) Bank of Items Menu: It permits the creation, correction, adding, deleting and listing of collected items.
2) Bank of Test Menu: It permits the creation of a test, analysis of the results, assignment of an optimal cutting criterion and creation of a disk with the validated test to be used by the students.
3) System Menu: It includes options to format, display directories, copy, eliminate and rename files and make back-up copies.

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EDUCATIONAL COMPUTING IN CHILE : TRENDS AND ISSUES

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ABSTRACT

The potential of educational computing has been a major point of recent studies and concerns in the Chilean education. This analysis examines the main trends of educational computing at the primary, secondary and tertiary level in Chile. The past, present and future of educational computing is analysed by considering variables such as computer literacy, teacher training programs in computer education and educational software production. The critical issues concerning these variables and their implications on the quality of educational computing are also discussed in terms of future curriculum implementations. Finally, in the light of the major trends and issues, and in keeping with the state of art of the research in educational computing, some recommendations are submitted to improve the quality of educational computing in Chile.

THE SHRINKING BUDGETS OF ELEMENTARY SCHOOL INSTRUCTIONAL COMPUTING PROGRAMS

Dr. John F. Beaver*

ABSTRACT

During the 1987-88 school year, a study was conducted to examine the budgetary allocations in high quality elementary school instructional computing programs. The findings demonstrate the budgetary decisions made by school leaders in a national sample of elementary schools identified for the excellence of their instructional computing programs. One of the most noteworthy discovery was the dramatic decline in instructional computing expenditures compared with previous years. The median average annual expense was $20; the median was less than $8 in 1986; for 1987, the median dipped to less than $5. Thus, after roughly five years of nearly $20 per student annual expense while developing its program, the typical school had lowered its computer expenditures to less than $5 per student by 1987. If the study's findings are indicative of budgetary practices in many elementary schools, then computer expenses are now plummeting instead of rising, as educators often suggest. School leaders must seek to alter this pattern.

INTRODUCTION

A study was undertaken during the 1987-88 academic year to investigate characteristics of elementary school instructional computing programs selected for their high quality. The study identifies common characteristics of the excellent programs and provides guidance to educational leaders to increase understanding of the processes used to develop and maintian successful elementary school instructional computing programs. The opinions of leaders whose programs are recognized for their high quality can be especially useful to other administrators seeking advice on how to best use the limited resources available to their schools for instructional computing.

OUTLINE OF THE STUDY

A national search identified 73 elementary schools with high quality instructional computing programs. The Office of Technical Assessment (OTA) in Washington, D.C., supplied a list of districts known for their support of instructional technology. Representatives from these districts then identified the particular elementary schools within their areas which they believed had developed the most outstanding instructional computing programs. The schools were surveyed with a 70% response rate. The study's instrument gathered data on various budgetary considerations. Among the aspects investigated were thse instructional computing program characteristics relating, either directly or indirectly, to budgetary practices such as the presence or absence of computer expenses as permanent line items in the budget, details of the 1986 computer budget, details of the 1987 computer budget, and the total expense on computer-related items.

FINDINGS

The first issue considered whether computer expenses were permanent line

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items in the schools' budgets and, if so, for how many years. The data showed that only 29% of the schools had computer expenses as permanent line items in their budgets. Of the schools that had computer expenses as permanent line items, 29%, varied in the length of time for which that had been true. 60% of those schools had maintained the line item for four or more years, 27% for three years, and the other 13% for only two years. However, nearly two-thirds of the school (56%) indicated that computer expenses were still not permanent line items in the budgets.

The second concern involved the level of funding available in 1986 and 1987 for computer related expenses. Perhaps the study's most notable finding was the striking drop discovered in budgetary expenses over the years examined. The first declines detected were from the average expenditures for the years that that programs were developed to the 1986 budgets. Further large declines were noted from the 1986 budgets to the 1987 budget levels. The median for the average annual expenses (incurred while programs were being established) was $20.00; for 1986, the median dropped to $8.80; for 1987, the median dipped further to $4.90. Thus, for the average school, after five years of nearly $20 per student annual expense to develop its program, the computer expenditures dropped to less than $5 per student by 1987. Of the schools supplying data, 64% spent less than $10 in 1987, 52% spent less than $10 in 1986, and only 12% spent less than $10 during the years spent were developing their instructional computing programs. These per student budgetary amounts are quite different from the figures supplied by either Moursund and Ricketts (ref 1) or Levin (ref 2).

It is worth noting that the average annual per student expense figure shows a strongly positive correlation with the averaged per student expenses for 1986 and 1987 (the amounts for those two years averaged). The data from the school responding to the necessary survey questions resulted in a Pearson Product-Moment Coefficient of Correlation (r) of .77. This finding supports the supposition that the pattern of declining comptuer expenses is very consistent across the entire sample of schools. However, the importance of the noted decline may be mitigated, to an extent, due to differences in the wording of the three relevant survey questions. In determining the average annual expenses, the data reflected expenses, regardless of the source of the funds. The data used to determine the 1986 and 1987 computer budget figures, however, reflected only the monies specifically available for allocation by the building principal. Nevertheless, it is worth noting that the average annual expense figures do not include either staff development or equipment maintenance costs, whereas the figures for 1986 and 1987 do. Thus, the decline in per student expenses was evident despite the inclusion of additional budget categories in the 1986 and 1987 figures.

Most likely, some portion of the total funds used to develop the high quality instructional computing programs came from sources other than the principals' budgets--for instance, fund-raisers or grants. Still, if the large differences detected were mainly attributable to outside funding sources, then those sources must have accounted for the majority of the available funds over the years that the programs were being developed. When figures for 1986 and 1987 are compared, the declines of 56% between the two medians and of 25% between the two means (from 1986 to 1987) suggest that the budgets may fluctuate widely.

The next issue involved the manner in which the monies available for computer expenses were allocated for 1986 and 1987. More than ½ of the schools spent less than $10 per student for hardware in both years. Well over ½ of the schools spent less than $2 per student for software in both 1986 and 1987. Staff development expenses were even less, with the large majority of schools spending less than $1 per student in both years Finally, equipment maintenance expenses were the smallest part of the budget, with the majority of schools spending no money at all on maintenance either year.

The major budget item both years was the purchase of hardware. Expenses for hardware were followed sequentially in importance by expenditures for software, staff development, and equipment maintenance costs. The mean 1987 per student budgetary figure indicated that 73% was spent on hardware, 15% on software, 9% on staff development and 3% on equipment maintenance. Therefore, the $4.90 per student was divided so that $3.57 was spent on hardware, $0.74 went to software, $0.44 was spent on staff development, and $0.15 on equipment maintenance. These findings also differ from those reported by either Levin (ref 2) or Hawley et al (ref 3)

SUMMARY AND IMPLICATIONS

Computer expenses are not yet permanent line items in the budgets of more than 70% of the schools surveyed. The median amount that school leaders spent each year for computer related expenses was roughly $20 per student during the years of the programs' development. That figure dropped to less than $5 per student by 1987. The 1987 per student figure ($4.90) was divided so that $3.57 was spent on hardware, $0.74 on software, $0.44 on staff development and $0.15 on equipment maintenance.

The per student expenditures supplied by the schools for this study are noticeably different from the figures supplied by either Moursund and Ricketts or Levin. Moursund and Ricketts predicted that per student expenses would total $8 for hardware and software alone (with expenditures tripling in a five year period). The percentages discovered in this study for hardware costs also differed from Levin's findings--nearly 75% to 11%, respectively,

Although not discussed in this paper, the study's secondary findings indicate that school teachers intend to shift their program emphasis for computer-assisted instruction to use of computer applications. A shift of this sort would make the study's budgetary findigns particularly important since application program use is frequently more hardware intensive than computer-assisted learning. If the projected shift becomes fact, instructional computing programs will need more hardware, and concurrently, more--not less--financial support. Each instructional leader must supply the necessary budgetary support. Obviously, the required support cannot be provided by schools with continually declining computer budgets.

Educational leaders must make long range plans to develop their instructional computing programs. Planning must take into account the unstable nature of computer budgets while attempting, where possible, to eliminate the factors creating the budgetary instability. In particular, administrators should strive to include computer expenses as permanent line items in their budgets. They should also try to stabilize the expenditure levels of their computer budgets and raise them to the level needed to implement the programs they plan to support. This may require substantial increases in established budget levels. The budgetary restrictions of the past several years have apparently had a great impact on the level of computer expenditure in the schools sampled. If the study's figures are indicative of budgetary practices in most elementary schools, then instead of rising, computer budgets are now falling rapidly. This pattern must be altered. Educational leaders must not view instructional computing as yet another passing phase.

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LOGO ENVIRONMENT: A NEW APPROACH IN ART EDUCATION

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ABSTRACT

Can computers help children to develop their aesthetic judgement? Should we treat the computer as just another new tool to be used in Art-Education? How should we deal with the concepts of the creative expression using such a new medium? In order to answer questions that concern Art-educators we have set up a project in a LOGO learning environment. Ten Ss (10/12 year olds) from a public art school were attended twice a week at LEC (Laboratory of Cognitive Studies). They were offered all the tradiditional materials to work with such as paper, pencils, paints, markers, besides the LOGO environment. The programming of Art projects by the Ss shows that it is possible to change the construct that Art must be set aside from reasoning as it deals with the imagination. Sensitiveness and reasoning come closer in a LOGO environment. Art concepts may even change.

INTRODUCTION

Art-Education deals with the imagination, with the magic, with the sensible. It also means production as Art is in intimate relation with the product that comes out of a process. Thus, both process/product become something unseparable.

In order to ivestigate these processes and the awareness of the Subject about himself we have offered him an environment which gives the chance to pursue the magic through reasoning. The computer becomes, then, an object which one takes hold of and turns it into a tool to help him thinking and creating (ref 1). It is used an interventional technic which supports and stimulates activities in order to make the Subject more self confident. The freedom to choose what to do and what to learn offers the child the chance to explore and to find new solutions.

Modern society makes it deep the distance between emotion and reasoning, placing Art that deals with the sensible far from reasoning. However, we see new forms in Art as a result of a of a new technology which stablishes, not only a relation but also a continuum to the process of creativity. Nowadays, the

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(1) S.Papert. LOGO: computadores e educação. (Brasiliense, SP, 1985).

experimental and investigative objective of Art is kept up by what has been called "technological art". How does the student take hold of this technology? It is of our interest to investigate this process.

Children who attend our Institution since when they are 6/7 years old go through a period of awakening of self criticism when they are pre-teenagers, which frequently causes a blocking of the creative expression and discontinues the involvement with Artistic activities.

Is it possible to help children go through this period without blocking their creative processes? What types of influence on the development of the aesthetic judgment of these Ss will we come to by letting them free to the access of their own creative expression?

OUTLINE OF STUDY

The Ss of this study are students at the Center for the Development of Expression, an Institution of the Council for The Cultural Development of the State of Rio Grande do Sul. The Ss of this study are students - 10/12 year-olds - who were regularly developing activities related to the Art field at the Institution. The Ss were attended twice a week, two hours each session. There was a total of 57 sessions. They were also offered materials to do traditional Art works: paper, pencils, paint, ink, brushes and so on.

RESULTS

The artistic production, the human expression through Art left memorable examples in the Pre-Historical caves. Now, at the end of the 20th Century, men have a new medium to express themselves: the computers.

The results, which are the present stage of our project, have been analysed under two aspects: the individual performance and the related production.

We have observed that at the first contact with the machine the Ss tried to look for more simple solutions, to "fill the screen" with colored lines. We consider this period the same as "scribbing". These products pleased Ss as the result was a surprise even through they were initial attempts.

The next step was to add movement to small forms drawn using "sprites". The kinetic: the form in constant movement. The possibility to put forms together through rotation, modullation, repetition at random, are some of the possibilities offered when programming in LOGO. This allows students to make new configurations from their initial form.

We have observed that, by creating and recreating, by exercising their imagination, by being able to program using a different language than their own, these children will be reorganizing their internal conditions in order to develop their aesthetic judgement.

As to the concepts of the artistic creation itself using a computer, we have observed during this study that:

1. Computer Art is an Art to be experimented. It is Conceptual by nature, once that the concept of artwork is diluted in the multiple representativity and it favors changes.
2. It is not an Art just to be printed like a print. It is a dynamic process.
3. The process is the product and the product is a developing process.
4. The work is open; it allows participation and interferences.
5. It is a new way of symbolic representation, a new way to decode configurations.
6. There is a need to recreate our visual codes as the colors generated by a light dot (pixel) are not the same as the ones made by brush strokes of pigments.

The computers will not only change our way of teaching but also, what we teach, according to Papert.

This has been a qualitative study, a pilot project, which will give us resources to make a new design for the next step of the research.

ANALYSIS OF THE MONITOR'S INTERVENTIONS: THE CLINICAL METHOD OF JEAN PIAGET USED IN THE LOGO ENVIRONMENT

L. Fagundes* & P. P. Petry*

ABSTRACT

At L.E.C., we are building a model of Logo learning environment in which the interaction childrenXmachine is mediated by the interventions of a teacher, that we call monitor, using the clinical method of Jean Piaget.

This method was originally used for knowing and building a theory about the epistemic subject. Nowadays, the way that we use this method in the Logo environments, introduces changes on it to attend the specific requirements on Logo programming and learning activities.

The study of these changes began using the data obtained on researches that studied the development of children's reading, writing and math's abilities on Logo learning environment.

The present study's methodology was the systematic observation of monitors' and children's performances and their relationship during a specified number of sessions on Logo environments .

This research, which isn't finished, allowed the identification of some variables that influence the monitor's formation and work.

INTRODUCTION

Initially, the clinical method was used at L.E.C. on psychogenetic researches. In order to study the cognitive effects occured at the Logo learning environments, many of our researches were done still using this method. In these researches the work of the teacher, who we call monitor and mediates the relation between children and machine, is embased , fundamentally, at the clinical method of Jean Piaget. The data we analysed in the present study belong to two of these researches. One studied the development of children's reading and writing abilities(ref 1) and the other studied the children's representation of the numerical positional system (ref 2), both related development changes of level with the interaction children X Logo environment.

Our most important goal is to build a way of training monitors that reduces the personal variations that damage the dev

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elopment of the child introduced on the method by them. In order to attain that, we look for the identification of the variables which influence them to make these undesirable introductions and the results of this act.

At the first moment, we made a bibliographic review about the original clinical method and about the monitor's inter-- ventions characteristics at the Logo environment. Piaget originally used it for knowing and building a theory about the epistemic subject. Nowadays, monitors should use it to know the psychological subject that works with the machine and provoke cognitive progresses on them. Therefore, the original clinical method can't stand without the introduction of new elements and we had to specify them embased on the consulted litterature.

METHODOLOGY

As written above, the data we analyse until this moment come from two other researches. It was obtained by systematic observations of the interaction between children, machine and monitor during a session of one hour. All the observators were trained in the same way and the monitor observed by each one changed often. They were thaught to observe and take notes of everything: children's and monitor's verbalizations, commands given to machine, the results of these commands and the time from five to five minutes.

At first time of analysing the observations, we really did not analyse. We read 130 observations of both researches and from all the 18 different monitors that worked on them and had observators taking notes between 1986 and 1987 and we wrote the 344 different interventions we found. 13 monitors were from the research that studied the development of reading and writing abilities and 5 were from the study of children's numerical positional system building. We always read at least 6 observations of each one: 2 from the beginning 2 from the middle and 2 from the end of the work with a child. There were cases that, at the sixth observation, the monitor still brought interventions that haven't appeared until that moment. In these cases, we chose to read more observations o f that monitor until there were no more new interventions.An intervention was considered new in function not only of it, itself, but according to the occurence or not of request of the child.

After that, we studied the interventions list and found 40 different kinds of them. These 40 were put into 7 different groups which were the cathegories used to analyse the observations lately.

We analysed observations come from 4 different samples(2 of each research) according to the formation received by the monitor. Each of them were composed of 2 monitors chosen at random. From each monitor(with just one exception) we chose at random 2 children and cathegorised the interventions(ref 3) of a number of observations that would give us at least 100 of them for each child. It means that, if at the end of the analysis of sessions we still didn't get 100 interventions, we would analyse the observation of one more complete session . The exception mentioned above was a monitor that din't have a sufficient number of sessions with a specific child. So that it was possible the comparision between her and the others,we analysed an aleatory chosen group of observations from all the children she worked with in order to get at least 200 interventions.

After classifying, we calculate the occurence proportion of interventions of each cathegory over the total number of interventions per each pair of monitor and child. We did the same with the total work of each monitor.

RESULTS

As written above, the interventions were divided into 7 categories. The first(I) comprises all the interventions prescribed on the original clinical method(ref 4) and on the monitor's interventions(ref 5) which intent to give him informations about children's hypothesis, plans, reflections over what happened or will happen and intent also to develop the cognitive processes behind these items. This last objective of category I is achieved through questions, comparisions, introduction and explanation of commands with request from the child(ref 6) and introduction of monitor's hypothesis with request of the child to be tested by her. The second(II) is composed by the interventions of first(I) improperly applied . This means: questions suggesting the answer(ref 4), monitor's introduction of commands without request(ref 6) and monitor's hypothesis without request. The third(III) is composed by interventions with or without request which suggest what to do, teach notions and correct them. There is also in this category the monitor's program activity of proper ideas that aren't challenges to the child. An example of that is to complete in the computer a geometric figure that the child is drawing and doesn't know how to finish. The fourth(IV) comprises all interventions that establish an affective relation between child and monitor, the reprocity of the child's and monitor's actions and authorities, the informations that can be obtained from the monitor and the ones that should be searched by the child. The fifth(V)(ref 3) contains all motivational reinforcement given to the child. The sixth(VI) comprises the inter-

ventions that depreciate the child. The seventh(VII) is composed by neutral verbalizations such as accomplishments, asking and giving of general information.
Our analysis of the data searched for the identification of variables that influence the training and the performance of the monitor. This identification will be used to make a new experimental design to search a model of monitor's formation. In all the 4 different formations of monitors, the interventions of I and IV were emphasized and the ones of VII were accepted, despite of the teachers and methods of each training have been different. We calculate the summatory of percents of I, IV and VII for each monitor and found a difference between the lowest(50.81) and the highest(76.85) sum. The sums of the other six monitors were distributed between these two points: 54.7, 56.5, 62.96, 71.83, 72.45 and 74.78. This suggests to us that the emphasis of the same intervetions and the existence of the same theoric basis are not sufficient to guarantee the same application of that by the monitor. The differences between the sums(I+IV+VII) of monitors who had exactly the same formation is considerable too, with only one exception. The 4 pairs of monitors got the following differences: 19.95, 0.62, 12.15 and 23.97. It's importan to notice that the second pair of monitors were the only ones who worked always in the same environment side to side with the researcher that formed them.
When we search the same kinds of interventions in the same monitors, we found an average difference of 8.99 percent in interaction between the same monitor with two different children. Another clue is the opposition existent between I and III. It was possible to notice that when I arises, III falls. This occurs with different children of the same monitor in a way that I+III maintains a regular value.
The next steps of this research will count with well-defined variables that will be controled in order to verify the influences of them in the formation and work of the monitor . From now, we will have to take into account the variables existent in the dialetic movement of the interaction itself.

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LINGUISTIC MICROWORLDS

Margarete Axt*

ABSTRACT

Talking about programming activity for children, we usually think of LOGO; and talking about LOGO programming, we rather think of it as using turtle graphics. More rarely, we get to think of children's systematic programming with words and lists as an aid in Natural Language. Considering this could provide an exceptional field for working with children in computer based environments, and for linguistic investigation as well, we have searched for making linguistic microworlds available. As far as now, collected data has shown LOGO can provide a rich environment in which children engage in Language activity and generating microgrammars can be as challenging as programming in graphics.

INTRODUCTION

In 1985, as we started our Research Project at the Laboratôrio de Estudos Cognitivos (LEC/UFRGS), programming activity for children was usually thought of as using the turtle graphics in LOGO language. At that time systematic programming with words and lists was not commonly meant for elementary school, and even not for high school, children. Therefore, our main aim was (1) to investigate the possibility of using "LOGO-words-and-lists" as an aid for children's thinking and learning in Natural Language. The other aims of the research depended upon the first one being, or not, successful. They were: (2) to comprehend how children understand and process linguistic information; (3) to verify the effects of computer based environments over the children's linguistic competence.

OUTLINE OF STUDY

As far as this initial stage (1985 - 1988) we undertook exploratory research through case studies. We found it necessary since we were working in an interdisciplinary area where technology, pedagogy, cognitive psychology and the approach to linguistic content were all innovatory. First we attended 15 children aged 11 to 16 years and then, in 1987/1988, we started attending 8 children aged 7 to 11 years. Children were volunteers both from public and private schools. Among them some were thought to be gifted and some others to have language learning disabilities. At the beginning, we used only one computer and children took turns

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to work in it. Some of them were asked to work in pairs and others, individually. Ultimately (1988) they were working in small groups (up to six), as to favor greater interaction among them. These arrangements should provide hints on the role played by social environment.

We develop intervention strategies based on the piagetian clinic method. They can be summed up as follows: (a) to provide linguistic content challenges and programming aids for intuitive exploration, quite systematically; (b) (although) to assure children the freedom to always devise their own goals; (c) to uncover children's actual linguistic and programming comprehension, the hypotheses they have about; (d) to get the justifications they developed for supporting these hypotheses; (e) to provoke discussion and reflection on the computer feedback toward procedure planning and debugging; (f) to provide the same toward increasing awareness of language structure and functioning.

The research data included recordings of the children's LOGO work (by means of disks, printer); observational descriptions of their behavior at work; and tape-recorded transcriptions of their spoken language and of the researcher's interventions.

RESULTS

Up to now, collected data have shown that "LOGO-words-and-lists" can provide a rich environment in which children engage in Language activity. Children's performance in linguistic microworlds may vary according to:
- the sequential order in which programming aids are presented. For instance, some primitives (first, butfirst, last, butlast) that are ordinarily introduced at the beginning in adult handbooks, were found to be the most complex ones for children to understand;
- the language style in which programming aids are presented. Understanding is helped by the adequacy of vocabulary, concepts and phrase constructions; clearness and lack of ambiguity in sentence building. On the contrary, understanding may suffer from the amount of information carried out by one sentence; the carelessly use of concepts already took for granted; the definition of new concepts in an adultlike form .... It didn't matter very much whether programming aids and problem-solving situations were put up in oral or in written form (except for the youngest for whom the interaction with the investigator was crucial). But it was really important the way adult verbal communication fit children's structure sentence and conceptual comprehension;
- entonation and mimic in oral presentation of programming aids, as well as visual aids in written presentation. The lay out of a written page, for example, was crucial for understanding: it was necessary to provide empty spaces inbetween sentences or drawings; and few instructions and short explanations intercalated by puzzling questions that

appeal to thinking. It was necessary to control the amount of explanations and the amount of sentences and drawings in a page; and the length of the sentences; and the use of suggestive drawings...
- the quality of challenges with regard to both programming and language contents. Children got motivated both by the expectation of unwonted results and by puzzles (since they were not too difficult). Problem-solving situations had to seem simple, at least at a first glance, and specially tentative;
- age periods. We may divide children in two main groups according to capabilities to overcome programming difficulties: children aged 7 - 10 or 11 years took almost twice the time to do the same things than the older group;
- personal styles. Although children with (language) learning problems took more time than usual, they were able to accomplish the same tasks. Other skills and abilities as attention, concentration, persistence, tolerance to frustration, pacience, solving-problems strategies, reading and concept comprehension, were also important in determining personal styles and performance for all children;
- social environment. Young and older children seemed to be more task-oriented when working by themselves. In this situation, the more children were young, the more they needed interact with the investigator and the more dependent they got on him. Older children didn't seem to resent so much from this. At the same time, all children got more free with the increase of interaction between them (specially in respect with the process of taking decisions and of developing problem-solving strategies - in respect to content learning things were not so clear and need some more analysis).

These results led to the idealization of two sorts of tools:

(1) a "LOGO-words-and-lists" handbook (ref 1) for young beginners. It was thought to be a tool for introducing important ideas and concepts in LOGO, as well as basic primitives for operating with words and lists. Besides, it should, systematically, provide for intuitive exploration on linguistic contents. At the end of it, children were supposed to have programation tools at hand so to start building microgrammars. They should be able to have sufficient autonomy as to make their own decisions on necessary programming aids. In so far programation styles and (linguistic) logic thinking would not resent from too limited programming aids. Besides all children would have quite the same aids to start building linguistic rules and it would be easier to compare how they could manage it. At the same time, it would be interesting to observe the use they made of the aids at their disposal, how they arranged them in procedures, how they managed to transfer knowledge from one situation to another.

(2) "seed-procedures", a software (ref 2) for intermediating

children's activity after they finished the handbook and before they started programming microgrammars. They were meant for simulating linguistic knowledge by the computer, although it be narrow. Thus, by means of comparing computer's correct or incorrect answers with their own language intuitions, children might become increasingly aware of metalinguistic processes. Thus it provided a field for investigating the way children comprehended linguistic rules brought forth in a task-oriented context. As a next step, children started building their own procedures in order to "teach the microcomputer more about Natural Language". Thereby children were enabled to simulate the linguist's task of constructing grammars. Only, they did it having in mind their own hypotheses about structure and functioning of specific aspects of their native language.

The analysis of the linguistic aspects will be the content of another paper in the future.

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IN SEARCH OF NEW RESOURCES TO LITERACY

C. Maraschin*, L.C. Fagundes*.

ABSTRACT

We studied the interaction between the first grade pupils and the computer based LOGO learning environment. This interaction promotes symbolic exchanges in three domains: the concepts construction of reading and writing , the numerical positional representation and the programming itself.

The different experimental groups we were working whith were formed by sixty children. There were children who have no preschooling or who come either from kindergarten or from special classes. In this last case, the children had histories of scholar failures or neurogical and/or psychological problem.

The results show an improvement in the subjects' concepts levels in the three domains studied. We have also observed that the teacher's interaction during the programming sessions can either help or hinder these symbolic exchanges.

INTRODUCTION

One of the great challenges in Brazilian system of education is to have school-aged children from low income families to obtain and to use the elementary representational systems of the culture: the written word and number.

The Ferreiro's studies, (ref 1) provides a new look about the reading and writing learning process. The write word concept psychogenesis we used as well the piagetian clinic method according Ferreiro to create the LOGO learning environment. We also used that to study the interactions of the subjects in that environment.

The objective of this study is to construct a computer based LOGO learning environment which promotes symbolic exchanges during the programming activities. We have observed the symbolic exchanges in three domains: the conceps construction of reading and writing, the numerical positional representation and programming itself.

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(1) E Ferreiro + A Teberosky, Los sistemas de escritura en el desarrollo del niño (Siglo Veinttiuno, 1979)

OUTLINE OF STUDY

We have been working since 1984 with different experimental groups which are formed by first grade children in LOGO programming environment settings. In 1987, we studied sixty children in three experimental groups: a)(31 Ss) either children who come from kindergarten or who have no preschooling; b) (19 Ss) children with histories of scholar failures; c) (10 Ss) children with neurological and/or psychological problems.

The main questions discussed are:

1 - Is the interaction with the LOGO language able to constitute an environment of differentiated symbolic exchanges accordingly with the subject's functioning conditions?

2 - Do changes of level happen on children's concepts construction?

The subjects went through two sessions per week working two in each computer. The sessions were registered in observation reports and child work was saved in flopping disks.

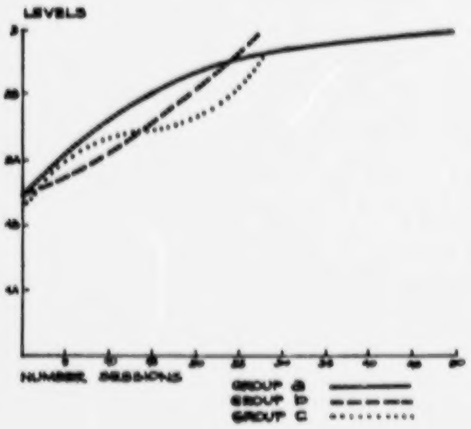
RESULTS

Following our initial questions we have tried to identify the changes of level (from first to fifth, each one caracterized by similar behaviors). We observed the subjects' concept construction according the differentiated symbolic changes which happened while in interaction with the LOGO environment.

After the final categorization, the results were saved in a data base, to make the following graphics.

The Reading and Writing Concepts Construction

GRAPHIC 1 - Development of the reading and writing concepts

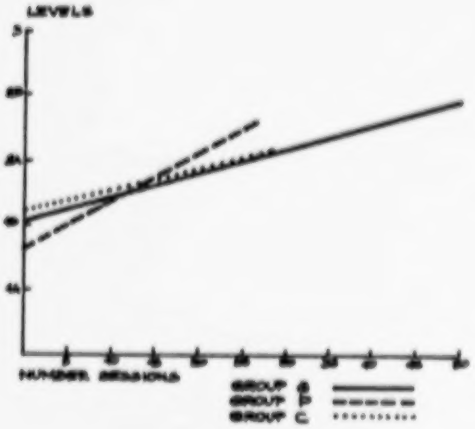


The most of the Ss started computer at the second stage of pre-syllabic level. The passage from the pre-syllabic to the syllabic level (when the child thinks that each syllabe may be written by one character) occurs first in group a (3rd session), second in group c (5th session) and last in group b (10th session). In the passage from the syllabic to the alphabetical-syllabic level, there are an inversion in the position of groups b and c. At this level, the child uses some letters which represent syllabes or phonemes. At the end of the study, the three groups has been reached the alphabetical level.

The Representation of the Numerical Positional System

GRAPHIC 2 - Development of the numerical positional system

The analysis of this notion was based on Burigo + Basso (ref 2)



The children in group b have started whithout having either the concept of number or its representation (1A level). Children in group a and c had a code for the representation of small quantities, but with no principles for representing a number. Although children in group b have started working in lower level than the other groups they got ahead of the others in understanding that we obtain a different number by putting two of them together. The children of group a, who had in the beginning a code for representing small quantities, took longer to reach level 2B. Another finding is that children of group c, who had a superior starting level didn't keep this difference at the end.

CONCLUSIONS

We have observed that the interaction with the LOGO language builds up an environment rich of symbolic exchanges, such as: linguistic communication, graphic communication, written representation of language, numerical positional system, and, above all, the construction and uses of the symbolic objects that are the programs.

The most significant evidence of this study is the possibility to bring about changes in the cognitive performance of the subjects in a period of 40/50 sessions. All of the Ss have presented changes in the conceptual levels in, at least, one of the notions studied. One of the reason why some children

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(2) E Burigo + M Basso, A construção de conceitos matemáticos na atividade de programação por crianças e adolescentes, (LEC/ UFRGS, mimeo, 1987).

have not changed levels could be related to the types of teacher's interactions which didn't allow spontaneous symbolic exchanges.

TECHNOLOGY FOR THE EFFECTIVE SCHOOL EXECUTIVE: NO LONGER A FUTURE CHALLENGE

D. G. Knezek*

ABSTRACT

The challenge facing school executives in pre-kindergarten through grade-12 education over the next decade is clearly one of effective leadership for transition. This leadership involves moving of schools toward accountability for efficient productivity, and the application of technology can foster characteristics of success. Modern information processing technologies will not come into appropriate use within schools in a timely manner by mere happenstance. Rather a deliberate and substantive offensive is required with the school executive leading the assult. Tested principles for effecting change are the leader's tools in this pursuit.

INTRODUCTION

The role of information handling technologies, including computing, in modern school leadership is no longer futuristic, but rather it is immediate and substantial. An increasing base of knowledge relating to characteristics of both effectiveness and excellence in the enterprise of schooling illuminates the nature of necessary changes for the effective executive, and the role of technology in supporting these changes becomes ever more clear.

OUTLINE OF THE ROLE OF TECHNOLOGY

The role of technology in support of data processing and business management in schools has long been recognized. Purchase of equipment, skills requirements of personnel, and contracting of services testify to a commitment within the educational community to discharge responsibilities in these domains through appropriate use of information processing technologies. While increased access to financial information, better cash management models, enhanced tools for data analysis and reporting, electronic funds transfer and more convenient storage and retrieval of information are in use by efficient and aggressive school systems, these have primarily been changes of degree. Appreciation and acceptance of technology's role in supporting efficiency and effectiveness here is not new.

Communication is key to effective leadership for productive schooling and, indeed, to the existence of universal public education in the nation. Yet, application of modern information processing to this task lags. Decision making at the campus level is recognized as crucial, and there is a significantly expanded cast of decision makers at that level. Team administrative structures and flatter organization of school systems increases requirements for efficient channels of communication. The environment in which school now exists is in many ways more removed from the enterprise and in others more intimately involved with it than ever before. Each condition presents its unique communication challenge.

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In order for the principal, staff, students, parents, and the community at large to have a clear understanding of the philosophy, mission and goals of the system, how these are developed and prioritized, and what the implications are for their local campus, clear, ongoing and interactive channels of communication must be in place. For a principal and other representatives of the school to communicate, in a quality way, the expectations for schooling and the opportunities it offers to both students and to the neighborhood at large, both the spirit and body of the school must be shared. Whether this takes place through news releases, handbooks, notes accompanying students home, newsletters or electronic bulletin boards and electronic mail, this is a natural application for modern electronic technology. And what of communication back to the school and up through the levels of the school structure? Whether it be from parents, staff, students or some other special interest group within the neighborhood, sampling of sentiments and encouragement of unsolicited feedback is facilitated through the use of enabling technologies.

The functional cabinet in the modern school structure has expanded beyond the deputy and assistant superintendents to include principals, co-op directors, and occasionally community leaders not formally associated with the school. This group is larger and more dispersed in both time and distance (and possibly ideology) so as to require more reliable and efficient communications than ever before. No longer can the cabinet be summoned at the drop of a hat to a face-to-face meeting of all the key players. Technology, however, can network this team in such a way that group decision making is a reality, and in such a way that this decision-making process can be more informed that at any time in the past.

The seemingly contradictory status of a school's immersion in its environment while being removed from it arises from the intimate nature of a communities interaction with the product of the institution without a great deal of insight into the educative processes. That is, the larger community is very aware of the level of fitness of newly hired employees, of students admitted to exclusive institutions of higher learning, of early dropouts from school, and of dropouts from society. Yet, few, save the highly motivated parent, know a great deal about what goes on in schools, about what problems they face, about the students themselves, or about efforts at school improvement. Similarly, the unsuccessful executive often learns too late of sentiments, perceptions, and either founded or unfounded discontent within the community relating to the schools. Exposing the public to processes of the school, making them aware of challenges faced by the school and of efforts to meet those challenges, and keeping a finger on the pulse of the community are all noble goals of communication which technology can facilitate.

After communication, evaluation offers the most fertile field for cultivating successful schooling. Through appropriate evaluation design clear expectations are established and communicated; through well executed evaluation credibility and respect are enhanced and climate is improved; and through use of knowledge gained as a result of evaluation informed planning and decision making come about. Traditionally evaluation has been too narrowly defined as measurement if placed in the hands of data processors, or how the experience is perceived from an affective view if placed with a less specification-driven counselor.

Clearly this is an oversimplification, precisely to demonstrate that evaluation is a complex, multi-faceted undertaking. While many school systems have personnel who are statistical marvels, and others who clearly are masters of particular instructional programs or processes, seldom are these folks encouraged or even permitted to either learn what is important to analyze on the one hand, or learn that what is important can indeed be objectively analyzed on the other. Concepts such as perceptions of appropriateness of programs and services, impacts on attitudes toward future learning, effect of particular arrangements on retention of students in school, and performance of subpopulations and of each individual student are important to school productivity and must be brought to evaluation. In order to prevent individual students or subpopulations of students from falling through the cracks, elaborate bases of data must be maintained and examined in disaggregated form. Tracking mastery by an individual is evaluation. A realization that statistical significance is not necessary for a statistic to be significant highlights the need to support evaluation with technology.

But even with appropriate and supported evaluation, productivity may not be increased. The evaluation department for one large urban school district with approximately 6.5 inches of evaluation summary per year is indeed well supported with technology, and members of that department are knowledgeable regarding important aspects of instruction. Yet, principals know little of the results of the evaluations done, and teachers know less. Even outstanding evaluation is not sufficient without effective communication, for there is no benefit to evaluation if results are not communicated to the point which, and in a form that, permits them to be applied for improvement.

SUGGESTIONS FOR CAUSING TECHNOLOGY TO HAPPEN

That the school executive must lead to be effective is true in the battle to promote technology in support of productive schooling. As a leader you must verbalize expectations. If the goal is to improve school effectiveness, efficiency and excellence through the appropriate use of technology, bring this to the forefront and say it. Modeling is always a powerful form of persuasion. Using technology personally for enhanced productivity establishes a model that will not be often overlooked. When interacting with staff, with the community, and across wider horizons apply the most appropriate technology. Modeling lends credibility to the words used to express the goal.

Beyond verbalizing and modeling there are techniques which help to inform and remind school personnel of the goal. Establish appropriate use of technology as a high priority target by budgeting sufficiently for systems, for training, and for joint assignments which require a technology wizard to work with a content area or process expert. As importantly, include this priority item in the evaluation of every employee in the system. A simple evaluative question such as, "Does this individual aggressively seek ways to be more effective in her/his duties through new or better application of emerging technologies?" might prove very effective. And, of course, tying recognition or financial reward to professional development associated with technology is motivating.

CONCLUSION

As the body of knowledge grows related to those things which make schools effective, efficient and high achieving, as the enabling tools of modern information processing technologies improve, and as successful models emerge for applying these technologies appropriately within schools the challenge to effective school leaders to tap into this support becomes more compelling. It is through deliberate, focused efforts that the executive can move his school into the present of information handling, thereby improving the instructional productivity at his charge.

DEVELOPING A COMPUTERIZED CASE STUDY SHELL

P.R. Gamble*

ABSTRACT

Some management students encounter difficulties in the transition from traditional teaching to case based work. By representing a case environment on a computer, a mix of frames containing text, business software and limited domain expert systems may be presented in a style which students can manipulate easily. A case study shell of this type appears to offer a promising bridge between CAL and intelligent tutoring systems. It has provided a powerful mechanism for cross subject integration in a multidisciplinary area whilst being generally well received by students.

SOME PROBLEMS WITH CONVENTIONAL CASE STUDY TEACHING

The importance of cross subject integration is especially evident in multidisciplinary, vocational management degrees such as those in hotel and restaurant administration. Group based case work is important in courses of this type because it exposes students to open-ended, conflicting situations. It may also foster applied problem solving, decision making and even social skills in an applied context.

However, these benefits are not without cost. In a substantial study the student has to understand and retain the artificial world of the case while seeking to apply a principal or technique learned in another context (ref 1). The very strength of group based learning may be lessened as the varying motivations, abilities and even availabilities of participants make themselves felt (ref 2).

The debate surrounding the validity of using case studies in management education is reviewed by Smith (ref 3). It is difficult to devise a case situation which accurately represents the complexities and inconsistencies of the real world. In addition, the case study method is highly dependent upon the skill of the tutor as the facilitator. Tutors can powerfully control the direction of learning yet learning under these conditions should be student-centred with minimum reliance on the tutor.

The solution to these problems may lie partly through the application of techniques used for intelligent tutoring systems. Roberts and Park (ref 4) propose that such systems might comprise three elements. These include, an expertise module (the content to be taught), a student module (a mechanism for understanding the progress of student learning) and finally a tutoring module (a method for providing guidance based on some inherent teaching strategy).

The difficulties of meeting these aspirations using current methods for generating computer based courseware have been noted elsewhere (ref 5) (ref 6). Too often the very worthy aims of using computer based tutoring

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are thwarted by some limitation inherent in the medium. Yet research has shown that in particular, the use of computers can both increase learning speed and raise the level of knowledge more effectively for groups than for individuals (ref 7).

THE COMPUTERIZED CASE STUDY SHELL - A NEW TOOL

The notion of a computerized case study shell seeks to utilize the power of the computer to provide organized access to a large set of data (the case material) and at the same time, encourage and guide students in the application of a variety of decision techniques. Such a shell, known as EXMAN for **EX**pert **MAN**ager, was developed as part of a $100,000 research programme conducted at the University of Surrey between 1985 and 1988. The shell or framework developed as part of this programme allows a tutor to string together facts, advice and problem solving tools to provide a complete, flexible work environment for student case study work.

Essentially the project aimed to meet three main goals. The first was to improve the operation of case work with student groups. The computer was to be used to provide support for students through the use of intelligent advice systems and by monitoring student learning. This computer based monitoring was also to furnish important feedback on the teaching and learning process. Secondly, it was intended to facilitate the availability of large, complex "case environments" to which students may be given access in whole or in part. A student could then explore the world of the case through the computer and thus needed to expend less effort on constructing and retaining it. The direction and pace of exploration would be determined by the student, thereby giving maximum control over learning strategy and the manipulation of content (ref 8). Thirdly, it was intended to expose students to the use of computer based power tools such as spreadsheets, databases and limited domain expert systems and to improve their confidence in using computers.

The techniques used to develop the case study shell drew heavily on developments in the field of artificial intelligence. Although AI techniques have scored notable successes particularly primarily when applied to problems involving some sort of diagnosis (ref 9), they are of great potential interest to management students (ref 10). Successful examples of expert systems usually relate to a well defined body of knowledge which is generally deterministic and stable in character. This is somewhat atypical of the ambiguous, conflict ridden world of management and decision making.

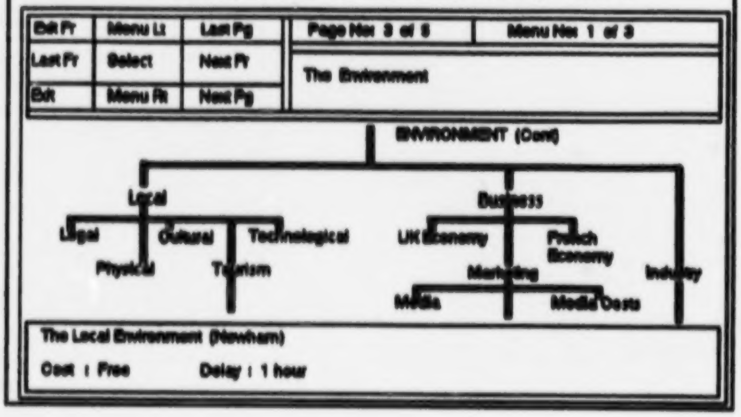
THE DESIGN OF THE CASE STUDY SHELL

The case study shell runs on an IBM PC AT. The overall system can be visualised in three parts. The first element is an editor. The shell is based on sets of frames structured in the form of a tree. The editor creates the basic framework for the case environment and controls frame linkages. Cost and time constraints for student access may also be attached to frames. New frames can be created or existing frames edited at any time. The second element is the frame contents. Frames may comprise text (created by Word Perfect 5), spreadsheets (from SuperCalc 5), databases (from Reflex) or expert systems. The latter may be from a shell (VP Expert) or especially written. These expert systems are a kind of adjunct to the fact frames.

The third element is the main retrieval system. This program provides a friendly user interface for the student and handles case administration.

Thus the program does the housekeeping on expenditures of time and cost for each student group and keeps a track of which frames have been selected. This information determines whether an expert system will be activated to query student understanding. Figure 1 demonstrates a high level frame illustrating part of the tree structure. Students navigate around the case environment by using keys on the numeric pad as indicated by the box at the top left side of the frame.

Fig. 1 Screen Layout from Case Study Shell


Edit Fr
Menu Lt
Last Pg
Last Fr
Select
Next Fr
Exit
Menu Rt
Next Pg
Page No: 3 of 5
Menu No: 1 of 3
The Environment
ENVIRONMENT (Cont)
Local
Business
Legal
Cultural
Technological
Physical
Tourism
UK Economy
French Economy
Marketing
Industry
Media
Media Costs
The Local Environment (Newham)
Cost : Free
Delay : 1 hour

A variety of techniques and programming methods have been utilized. In addition to commercial business programs, the custom programming was carried out principally in Turbo Pascal (for the editor and the EXMAN driver) and Turbo Prolog, for some of the expert systems. Future developments will probably result in the EXMAN driver being re-written in Turbo Prolog. In its present form, the total system comprises about 250 separate files occupying some 1.2 megabytes of disk space.

SOME EXPERIENCES WITH THE CASE STUDY SHELL

The first case study developed for the shell concerned the proposed take over of a London docklands hotel by a rapidly expanding French budget hotel chain. Student groups "working" as consultants for the French chain reviewed both the tactical and strategic implications of the situation and made a report and presentation. Thus the problem encompassed, hotel operations, corporate planning, marketing strategy, international finance and even tourism developments.

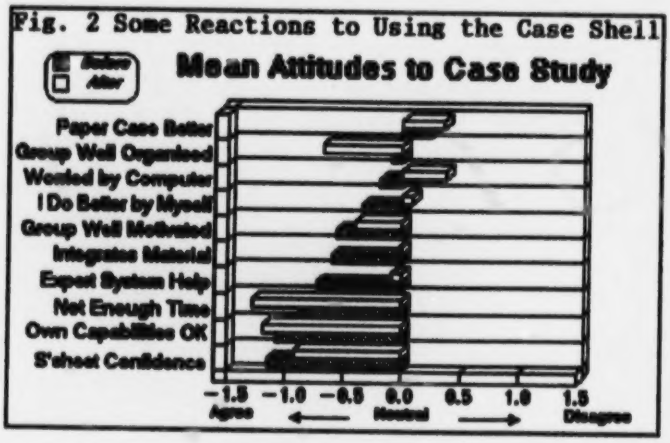
As in conventional group based case work, student teams experience the normal problems associated with group functioning. However, constraints of (artificial) costs and real time introduced by the computer heighten the need for planning and may have increased the sense of pressure. Computer literacy skills were developed as a by-product as students used standard business software to structure and solve sub-problems. Since the computerized case was dynamically updated from time to time, this flexibility improved tutor interaction in the learning process. A new frame might include extra advice. The need for specialist faculty to work closely together as they determine the form and style of new frames improved the integration of teaching material.

AN EVALUATION OF TEACHING AND LEARNING BENEFITS

Student reactions have been monitored in various ways over the progress of the project. Methodology has included video tapes of interaction with the system, group interviews, depth interviews and questionnaires. Some findings clearly relate to case work in general and are not specific to a computer based problem. In its current, third version, tutors have noted distinct improvements in the quality of the reports submitted, sometimes to a standard that would stand favourable comparison with commercial equivalents.

An evaluation of student responses to a series of Likert statements evaluating attitudes to the computerized case before and after completion of project work are (partially) summarised in figure 2. Reaction to the use of a computer based case is generally favourable. As might be predicted, there has been a significant reduction in concerns about computer use. The main difficulty appears to be that of time management. Before starting, students estimated an average time requirement of 7.8 hours (over seven weeks). In practice they averaged 21.6 hours. Group working also created some problems, though foreign students were less inclined to believe that they could have done better alone (X^2 = 14.56, df = 4, p (.05). Expectations of support from the expert advice systems do not appear to have been met fully. Further investigation revealed the focus of concern to be mainly the nature of the feedback from the systems and limited flexibility. In general high performing groups rated the expert systems lower, presumably being better prepared, they perceived themselves to gain less.

Fig. 2 Some Reactions to Using the Case Shell



SUMMARY

The case study shell enables faculty to produce comprehensive, dynamic case studies more easily and allows them to monitor and guide student progress more completely. It also encourages students to apply computerized management tools to ambiguous and complex data in a planned way.

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KINDERGARTEN CHILDREN EXPLORING THE COMPUTER

P. A. Ferguson*.

ABSTRACT

This paper outlines the findings of an ethnographic study of 5 year old children who were given the freedom to use a computer word processor to explore the problems they chose. At some stage all children in the study chose to use the word processor to solve problems of how the computer works. In this paper the statement "how the computer works" refers to such computer functions as wrap around, the repeat function, as well as to exploratory keyboarding activities such as 'hunt and peck', 'QWERTY', and rudimentary 'touch typing'. The children seemed to choose the same activities with the computer and to use many of the same strategies to 'figure out' the machine. More technoliterate children used the computer for more 'adult activities'; the most wary children appeared to have negative experiences with technology in the home (they were specifically forbidden from touching home equipment).

INTRODUCTION

This study begins with a discussion of some assumptions implicit in the educational use of computers, and focuses on the nature of computer hardware/software and the schools. Many of the software programs used in education are grounded in assumptions about the nature of knowledge which are rooted in a 19th century mode of thought (ref 1). Schools are conservative institutions and have taken fragmented approaches to the introduction of computers. However, we are now in the computer age and children are growing up surrounded by computers.

We need to look at the effects of different experiences children have on the ways in which they interact with computers. We also need to observe and describe the ways in which children will use computers if they are allowed to freely explore them, using a program that allows them to utilize their own problem solving strategies to figure out the computer. This study observed, described, and analyzed individual and group patterns that 12 kindergarten children exhibited when they wrote on a computer word processor.

People in the technologically advanced nations are living through and witnessing, sometimes unconsciously, the quiet revolution, the "Computer Revolution". As more societal institutions, from families to industry, put faith in computers, they put pressure on educational institutions to implement computer courses in the curriculum. Schools are responding to these urgings by incorporating such courses into the existing curriculum.

A major concern is that children should become "computer literate". Another concern is that schools should redress imbalances in social equality and provide computer classes to both those students who have home access to computers, and to those who do not have that access. Unfortunately, research shows that the practice of schools exacerbates the gap between students who are experienced and those who are not (ref 2). Experienced students are given stimulating problem solving activities which encourages them to become more computer literate. Inexperienced students receive teacher directed experiences in the curriculum skill areas, and they do not get to explore the computer, and use it for problem solving. The gap between the haves and the have nots would seem to widen, and the aim of computer literacy for the inexperienced may not be achieved.

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Children's play and repetitive actions are purposeful and help children consolidate their understandings held in their schema. Knowledge and meaning are added to schema by practice, assimilation, testing, and accommodation. The repetitive style of young (and old) learners is a form of practice and testing of their emerging theories about knowledge and language (ref 3).

At this stage in our knowledge about the uses of computers, their effects on society and children, current educational practices, the nature of language and writing acquisition, the nature of the writing process, and the ways in which children explore their world using their own problem solving strategies, it seems necessary to expose young children to computers and word processing and observe and describe the different ways students interact with and solve the puzzle of the computer.

THE STUDY

A group of 12 randomly selected students -- 6 girls and 6 boys -- from a Eugene, Oregon, public school kindergarten were shown how to use the simple word processing software program Magic Slate. On 5 separate occasions, lasting between 9 and 44 minutes, students were observed and videotaped using the computer word processor in the school's computer room.

Observational, and videotaped data were transcribed, coded, described, and tabulated. Ethnographic and ethological descriptions of students' activities were used to code behavior patterns for tabulation and analysis. Each videotape was viewed at least 5 times using normal speed, slow-motion, stop-frame, and fast forward search modes to facilitate behavior descriptions. The tabulated results for the various categories of behavior were searched to detect patterns of similarities and differences among students. The patterns detected in the many tables were compared showing further similarities and differences among students.

Students were then grouped into 4 major groupings based upon the decisions made after comparing the data on(a) the amount of writing activity across sessions compared with the amount of experimenting, and (b) the quality of the written products of the students (students' names have been anonymized, Group A names begin with A, Group B with B, Group C with C, and Group D with D).

RESULTS

The summary of major findings on writing behaviours, home background and socio economic data are discussed elsewhere (ref 4).

Analyses of the observational and videotaped data revealed that the children all used one or more of styles of typing to create text and/or patterns on the screen. Most children also retained much of their products to have it printed off. Those children who were concerned to produce text used mainly the Hunt and Peck style. The other styles of typing were related more to the experimental procedures adopted by children as they explored the computer's capabilities. All but one student used a Hunt and Peck style of typing to produce text, and students used a Hunt and Peck style for typing names, words, the alphabet, and/or numbers. Some students used rapid Hunt and Peck typing when producing familiar names and words.

When students experimented with the computer they chose from a variety of typing styles. Typing styles varied through Random key pressing with a single digit on one or other hand (sometimes students changed hand for a time), QWERTY typing using a single digit on one or other hand along a single row of keys, or alternating along 2 rows, Repeat typing, where a digit repeatedly struck a single key very rapidly, or the key was held down for periods greater than 1 second, to pseudo Touch Type, where multiple digits on one or both hands were used to strike multiple keys alternately, sometimes the fingers or hands were stroked pianistically across a row or rows of keys.

An important finding was that 7 students (nearly 60%) did experiment with the computer and with different typing styles. This indicates that the computer word processor stimulates exploratory behavior in young students. They are using their own problem solving strategies to figure out how the computer works and what they can do with it. Only 2 of these students had had experience with computers before, Cora, who experimented least, with a video game machine, and Cleo, with an Apple //e computer. Cleo's experiences with her family's computer were with the software program Print Shop, with which she could select pictures to be drawn on screen and paper. This program is menu driven and allowed her little freedom to explore in a simple manner the capabilities of the computer itself. Candide, Cassie, Damian, and Doreen were all very inexperienced with any form of electronic technology. Both Cassie's and Damian's parents said their child was too young to be allowed to touch their TV or VCR.

When they experimented all students were intent on observing the results of their actions on the screen. One common discovery all made was the repeat function keys including the Delete key. When the repeat function was discovered the student would hold a key down for varying lengths of time while watching the screen intently. All at first showed surprise when the symbol "ran on" for varying lengths of time after the finger had been removed. All but one of the students who experimented showed deliberate manipulations of the times of key pressing. Most made comments about the significance of holding the keys down for varying times. Several became annoyed with themselves when they accidently deleted more than they intended.

Students' use of experimental typing styles produced more volume of copy than did Hunt and Peck typing of stories, names, words, the alphabet, and numbers. Written story text required the most time to produce.

All students were interested in the printing process. Only 2 lost interest in the process and wandered off to do other things during printing. Length of the product was of most importance to the "Experimanters".

DISCUSSION

The great 19th century French painter Georges Seurat (1859-1891) burst on to the French art scene at the age of 24. Art critic John Russell writes about this event:

> It would be the wildest romancing to suppose that a picture like the Baignade results from anything but the most careful and elaborate preparation. Not only was the final version preceded by a great deal of preliminary experiment (fourteen sketches in oils exist for the Baignade, and there are ten related drawings) but the capacity to attempt such a picture at all, in the year 1883-4, implies a sustained and prodigious effort of knowledge, will-power, meditation and historical sense. (ref 5, p.9)

If we are to revere the exploratory efforts of adults such as Seurat, then we must not denigrate the same efforts of young children as simply "fooling around". Nor must we underestimate the powerful learnings children obtain from the very serious activity of play.

At a glance, many of the results of this study could be described in terms such as fooling around and playing with the computer. But, were they simply mindlessly fooling around? Or were the students who experimented with the computer exploring the computer's capabilities? The students' eye movements, their talk, and their predominantly neutral facial expressions all indicate that they were no less serious than Seurat probaby was when he was making his many preliminary sketches and drawings for the Baignade. The only difference is that we know what Seurat's final product was and can deduce the purpose of the preliminary work in retrospect. We have not the same advantage of seeing into the futures of these students in this study. Who knows what they will do with the grounding they have had with the computer word processor?

The computer's power to stimulate exploratory behavior in children is further supported by the experiences of the other 5 students who did not experiment in the study. Of these, 3 did experiment with computers outside of the school setting. Albert nearly drove his father to distraction at one stage when all he wanted to do was experiment with the repeat function. Albert's father said he would come home to find his directory of files filled with E's or some other letter. At that time he observed Albert holding a single key down while watching the screen intently. Eventually Albert had worked out the relationship between the length of time the key is held down the the length of run-on on the screen. Albert got over this experimental phase in a short time, and moved on to using the computer as graphics and writing tool. Alicia and Anthony also had opportunities to do this kind of exploration with computers before the study began. Benjamin's mother said that he had used the computers in the public library. One day he had caused some problems with the computerized catalogue system. Maybe Benjamin had also experimented with the capabilities of the computer.

Probably only Brad had not experimented with computers at any time. Brad's comment that his "Dad would kill me" if he touched the computer may explain his tentativeness with using the computer as a writing tool. It would also explain his reluctance to experiment with the computer. He was afraid to do anything with the computer because it is an adult tool in his home, and not to be fooled around with by children. I suspect that his wariness was diminishing, and with further encouragement he too would have experimented.

The implications of this finding is that students should be given all the freedom they require to explore the computer. The best kind of software for this purpose is probably the word processor because it allows them to explore without the fear of errors. The word processor displays everything that is typed on the screen, so students can immediately observe the effects of their actions. Other software programs do not allow this freedom. Even a program such as Logo has to follow a specific pattern of commands, otherwise it will not operate. Presenting young students with a high level of computer experience with drill and practice type programs does not make children computer literate if they cannot explore the computer to solve their own problems.

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A Technology-based Learning Environment

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ABSTRACT

Recognizing that our society is in passage from the industrial age to the information age, Jenks Public Schools is implementing a program which utilizes emerging technologies to transform the traditional teaching and learning processes. Currently, the project is in the pilot stage. Four lead teachers from the core academic areas of Science, Mathematics, Language Arts, and Social Science are involved in program design activities, computer training, curriculum revision and design, and courseware and software evaluation and selection. The primary activity of the project is to provide a transformed teaching and learning environment which allows self-paced instruction through the use of integrated technologies. The technology-based curriculum will include instructional materials for complete courses in the core areas. The formal project will span four years, August, 1989 through June, 1993. A formal research study will compare the 120 students in an experimental group with 120 others in a traditional environment as a control group and includes a follow-up longitudinal study.

PURPOSE

The Technology-based Learning Environment is a joint effort of Jenks Public Schools, Memorex Telex, Apple, Novell, Optical Data, Computer One, University of Tulsa, and Oklahoma State University to provide an alternative to the traditional means of instructional delivery and learning in Science, Social Studies, Language Arts, and Mathematics. Recognizing the changing forces of educational reform and the increasing capability of technology for the transmission of knowledge, this project has been designed to promote the development and piloting of a technology-based learning environment which integrates computer and communication technology with Human Resources. The goal of this project is to create a system that can transform teaching and learning. The traditional approach to education will be replaced by a flexible, child-centered, self-paced environment which empowers the student to become a master of the processes that contribute to his continued growth. The role of the teacher will also be transformed into one which maximizes his contribution to the education process.

BACKGROUND

A review of educational trends and practices reveals that the calls for reform over the past several years have not gone unanswered. However, the attempts at change have been mostly ineffective and unsubstantial. Regardless, the calls for reform are clearly on the increase. For example, in 1986 three major national task forces representing the U.S. Department of Education (ref 1), the National Governors' Association (ref 2), and the Carnegie Forum (ref 3), all agreed that the established public educational system was in need of not simply reform, but transformation. Perelman (ref 4) has also recently described the imperative to transform American education into something fundamentally different from what now exists. The one pervading theme for which there is consensus is that transformation of education is essential. The problem is that no clear model of how to proceed to accomplish this type of change exists. It is our view that transformation will not occur without a fundamental paradigm shift,

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one that allows our perceptions of learning and teaching to be seen and understood in a context other than the traditional structured school environment.

We are piloting an alternative learning environment based on four major premises: 1) In order for technology to function according to its full capability as a tool for teaching and learning, it must be used outside the time-in-grade, time-in-class concept by which schools are structured and organized; 2) The teacher will remain an integral part of this alternative learning environment, but his role will be altered substantially to one of manager, diagnostician, subject matter expert, small group facilitator, technology specialist, etc.; 3) When students are given the responsibility for their own learning in this type of alternative environment in which technology allows self-paced, individualized, mastery learning and personalized guidance by professional educators, productivity will be maximized; 4) Since the transformation of education requires the transformation of a social institution as well as the appropriate utilization of technology in a integrated system, experimentation should be done within the local school community; that is, as a school within a school.

METHODOLOGY

The Technology-based Learning Environment has been designed as a four year project involving four teachers and 120 incoming freshmen beginning in the Fall of 1989. Instruction will be primarily technology-delivered and will eliminate the time-in-class, time-in-grade structure. A pilot has been designed to provide data, validate concepts and guide the planning for the formal 4-year project. Pilot activities began January 30, 1989.

Physical Design: Physically, the project expects to utilize four to eight classrooms within a traditional school setting. Two classrooms are equipped each with intelligent workstations in a networked environment that provides access to CD-ROM, video disk, and other shared peripherals, as well as sophisticated management system and user interface. Both Apple and IBM compatible hardware are utilized. The other rooms are used for small group or large group instruction, evaluation of student performance, project work, peer tutoring, seminars, and student presentations. Recognizing that hands-on application of scientific principles is essential to the learning process, teachers have access to a modern science laboratory. Additional support for this project comes from the media center which contains facilities for audio-visual development and presentations, on-line retrieval capabilities, slide or photography production, satellite reception, and research opportunities. In working with students, the library media specialists will provide a systematic program of instruction and guidance in the location, retrieval, evaluation, and use of information sources and technologies as well as the interpretation of information.

Curriculum Design: In transforming the teaching and learning processes, teachers are redefining the traditional pattern of instruction. The lead teachers are reviewing current course objectives and state-mandated student learner outcomes to establish a conceptual basis for each course. However, the critical issue in this project is not traditional ordering of these concepts but the mastery of them. Teachers are working to realign these concepts with real world learning and thus are restructuring the traditional framework. For example, Social Science will no longer be taught as discrete subject matters, but will be integrated into each of the core subject areas; students will begin their studies with an historical perspective of each of the core areas.

A central aspect of curriculum development is evaluating and selecting appropriate courseware and software. This is an on-going, time-consuming process but critical to program success. When teachers realize that no courseware exists or that which does is weak and ineffective in the mastery of designated concepts, then they have the opportunity to initiate the design of software appropriate to their needs.

Believing that all learning is interrelated, teacher participants work with each student participant to develop a personalized education plan that provides a wide variety of learning experiences but is outcome based. A basic premise of this entire project is that students are not expected to learn the same things in the same way or in the same amount of time. Each child's instruction begins at his current learning level, not necessarily at grade level or ability level; the student receives credit when mastery occurs. Projects designed to demonstrate application and transference of learned information provide opportunities for interdisciplinary activities which reinforce concept building, problem solving, information-based opinion formation, creativity, and analytical thinking. One objective of this project is to produce self-directed learners who can demonstrate adaptability in a fast-paced, ever-changing global society.

Evaluation: This quasi-experimental study will measure the effectiveness of instructional practices over a four-year period. Comparisons will be made between students who participate in the transformed learning environment and an ability-matched group of students who remain with the traditional high school format. The independent variable of restructuring of the school environment utilizing computer technology is expected to impact both students and teachers. The dependent variables to be measured will include: (1) achievement and higher order thinking skills; (2) student satisfaction, teacher job satisfaction, and parent support; (3) time required to complete objectives of designated courses; and (4) preparation for real world activities/life-long learning.

120 ninth grade students will be selected from those who volunteer for the project. Students will be selected for the program to mirror the proportion of low, average, and high ability students in the total Jenks ninth grade population. The control group will consist of an ability-matched sample of 120 ninth graders who are participating in the traditional high school environment. The 30:1 ratio of students to teachers in the treatment group will be similar to the ratio provided in the traditional high school.

The Otis-Lennon School Abilities Test (OLSAT) will be utilized to measure the general ability of students during the selection process. Achievement will be measured annually with the Metropolitan Achievement Test (MAT6). Self-report questionnaires will be utilized to measure the students' attitude toward the subject matter, computers, and instruction. The self-concept will also be studied by standardized inventories. Questionnaires to measure teacher and parent satisfaction will be developed. Longitudinal records will be compiled by surveying graduates every two years for eight years. Information concerning post-high school education, occupation choice, preparation for the future, use of computers, and feelings about high school will be requested.

The statistical analysis relevant for this design will be to calculate gain scores in achievement. Analysis of covariance will be used to determine if the experimental and control groups differ significantly on college entrance examinations, attitudes, time required for subject completion, and indicators of long-term success.

IMPACT OF PROPOSED RESEARCH

The proposed research has broad possibilities for impact because of the nature of the program.

1. Teachers from traditional environments will work with experts, university consultants, school district personnel, and industry participants to retrain

themselves for working in a technology-based learning environment. A study tracing the transformation of teacher to facilitator will provide valuable data for teacher preparation programs.

2. Mastery learning is a driving force in this program. The use of technology, retrained teachers, and a transformed classroom structure as the foundation for a mastery learning environment will be thoroughly documented and evaluated.

3. Computers and communications technology will provide enhancement not only through their ability to enrich the learning experience but also as the foundation of a self-paced individualized learning environment. Data concerning the blend of technology and a personalized education plan and their impact on active and/or passive learning will be studied.

4. In addition to cognitive measures, research in affective areas will provide valuable data concerning how students and teachers deal with the changes required of them to function productively in a technology-based environment.

5. The interaction of private and public sectors can allow the design and creation of a curriculum which is consistent with the skills and/or retraining necessary for productivity in a global society.

6. Longitudinal studies involving four years of the project and follow-up contacts give researchers a clearer perspective of the long-term effects of student participation in a technology-based learning environment.

SUMMARY

This project represents a unified effort of industry and public education to provide an educational alternative to traditional instruction. Although computers have been acquired at an increasing rate by public schools, rarely have they altered educational practices in any substantial way. The primary reason for this is that educators have tried to "force fit" computers into a structure and organization that was designed for different methods and tools. However, technology allowed to function at its full capacity in a flexible, creative environment can provide a foundation for real transformation of teaching and learning.

Our goal is to create an environment that takes advantage of today's tools and produces young people ready for tomorrow's world. Quality education of this type will require technology utilized in transformed schools through the joint efforts of business, government, and education.

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COMPUTER LEARNING MONTH

COMPUTER LEARNING MONTH 1989: WHAT IS PLANNED FOR THIS YEAR AND HOW CAN EDUCATORS PARTICIPATE?

Sally Bowman*

ABSTRACT

The Computer Learning Foundation is an international non-profit public service/public education project whose purpose is to help people of all ages learn more about the benefits of using computers at work, at home and at school and learn to use them more effectively. Every October, the Computer Learning Foundation hosts Computer Learning Month and distributes millions of copies of free books and materials through ocal events and stores. In addition, during October, the Computer Leaning Foundation also hosts numerous contests and awards thousands of dollars worth of computers and software to winners. Information on how to participate in Computer Learning Month 1989 is available in presentations by the Computer Learning Foundation, in their exhibits at major educational shows and in the *Official Computer Learning Foundation Publication*, available by writing to the address above.

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COMPUTER LEARNING FOUNDATION
1989 PROJECTS AND PROGRAMS

GENERAL PUBLICATIONS

1) Preview Publication (Publication Date: February 15, 1989):
   - **Review of 1988 results, contest winners and materials availability**
   - **Preview of 1989 plans, and**
   - **Announcement of teacher training program competition and sweepstakes**

2) 1989 Official Publication (Publication Date: May 1, 1989): Includes complete details on 1989 programs, contests, materials and ordering procedures.

3) October 1 Update (Publication Date: September 15, 1989): Announcement of teacher training program winner(s), any new sponsors, corrections or new information and complete list of locations distributing CLM materials locally (local stores and outlets).

PROGRAMS/MATERIALS FOR PARENTS OF CHILDREN AGES 3-21

- **Everything You Need to Know (But Were Afraid to Ask Kids) About Computers:**
  1988 book edited to be more generic (less focused on just learning) and appropriate for parents, educators and adults needing basic information on computers and software and how to use them.

- **Preparing for a Career in the 21st Century:**
  Reprint of 1988 book for parents, educators, students and adults with information on the use of computers and software in non-computer and non-technical careers and how parents and students can begin preparing today.

- **CLM Event Kit:**
  Kit for schools, PTA's, user groups, community groups and local stores hosting local events for parents and kids during Computer Learning Month (October). Includes books, planning guides, Computer Learning Month banner and poster.

- **Contests**
  - Video/computer presentation (or storyboards) that teach children or adults about the benefits of technology
  - Storybook
  - Computer Learning Month Event

- **National Kickoff in Washington D.C. of Computer Learning Month in October**

PROGRAMS/MATERIALS FOR SCHOOLS AND EDUCATORS

- **Poster/Calendar:**
  Twelve month calendar which includes photographs of the best 1987 and 1988 contest art and information on the value of computers. Key Computer Learning Month dates will be included on the calendar. Promotes CLF, CLM and the value of computers and appropriate for dealers, schools, libraries and community groups.

- **Lesson Plan Books:** Edition I and Cooperative Learning Lesson Plan Books will be distributed in a CLF binder. All lesson plans will be loose leaf pages for insertion into the binder year after year. All lesson plan books are sold at cost.

  Edition I (Three books: K-5, 6-8, 9-12; 64 pages each):
  Reprint of 1988 books. Best lesson plans from 1987 general lesson plan contest.

  Cooperative Learning (Three books: K-5, 6-8, 9-12;64 pages each):
  Best of lesson plans submitted in 1988 cooperative learning lesson plan contest.

  Special Education (K-12; 64 pages):
  Best of the special education lesson plans submitted in 1988 lesson plan contest.

  Telecommunications (Grades 6-8; 32 pages):
  Lesson plans involving the use of telecommunications, developed from 1988 telecommunications lesson plans and telecommunications dream project contests.

  Early Childhood (32 pages):
  For early childhood educators and day care centers: lesson plans selected from the best entries in the1988 early childhood lesson plan contest.

- **Teacher Training Television Public Broadcast:**

  CLF has formed a partnership with Software Communication Services (part of a Chicago PBS Station) and will begin broadcasting 15 minute segments weekly to schools through local PBS stations throughout the U.S. and Canada in February 1989. Broadcast segments will include the the best teacher training programs received in spring 1989 Contest, exemplary program closeups, teacher training on lesson plan ideas and trends in technology, among others. The editorial board has representation from both the NEA and AFT and experts in public broadcast, education and computer training. Print support material to supplement the broadcast, when available and appropriate, will be made available at cost. Video tapes of the segments will be made available at cost through CLF. Viewers are encouraged to videotape the programs locally for later viewing.

- **Teacher Training Workshops:**

  CLF will host teacher training workshops at major educational shows that allow us to partcipate. CLF will invite the local teachers whose lesson plans are published in CLF materials to join us in the workshops. CLF will honor these leaders in integrating technology into the curriculum and then rotate groups of teachers around the workshop where they will be shown how to integrate the lesson plan into their classroom by the teacher who developed it.

COMPUTER APPLICATIONS FOR TUTORING AND COACHING PHYSICIANS FOR MEDICAL LICENSURE EXAMINATIONS: INDICATIONS FOR THE 1990's.

William M. Schmitt M.D.

One procedure for measuring competence in the medical profession is testing;routinely and constantly fo clinical skills and theoretical medical content by established professional organizations at the state level(FLEX exams), federal level (National Bd. exams); and the professional level (A.M.A. and the Academies). The physician to be tested , uses various means and techniques to prepare himself for the test, including seminars, crash-courses, tutorials, self study programs, and prepared test taking materials. In each of these test taking mechanisms, the computer plays a strategic role in enhancing the learning and recall mechanism and promises to have an even more important role when more sophisticated programs are developed and physicians feel more at ease with the computer. This presentation will discuss the interaction between the physician learner and the computer; the computer's role in preparing and instructing the physician. Simple questions will be asked and answered pertaining to this role.

What has been the relationship between the physician and the computer?

Before any computer can be used as an educative tool, the learner must be computer literate. Studies done by Bresnitz and Stetten, have shown that 42% of all medical students have had no previous experience with computers prior to entering medical school, 28% have had less than one year, and the prior experience involved research and word processing skills or using established programming language such a FORTRAN and PASCAL. In fact the study showed 73% of the medical students would take a computer course if offered in the medical school. Therefore, the medical student and thus the physician is basically unprepared to handle the computer well.

What are some of the personalized instruction advantages of the computer which promotes learning?

Williams and Burnet discuss some unique characteristics of the computer:
self paced instruction,
active learning,
mastery learning,
individualized content,
prompt reinforcement.
individualized evaluation,
entertaing instruction,

opportunity for testing ideas,
privacy in the learning environment.

The delivery is standardized, constantly available and cost effective.

What are the names of the best types of learning programs?

Three broad categories of programs can be defined; CAI, CAA, CMI. CAI or computer assisted instruction enables all students to have an opportunity to learn by interacting with their teacher through a computer program presented at a terminal. The teacher gives immediate feedback. CAA or computer assisted assessment refers to formal assessment of student performance by means of progrmas presented at a computer terminal. The feedback is purposely omitted and there is no opportunity for self assessment. CMI or computer managed instruction may administer a whole course or part of it.

Why is the CAI the best type of computer instruction?

CAI permits a dynamic interaction between the student and instructional program not possible with most media. Learners have control of the situation, they select the lesson, thhe answers, and proceed at their own pace.People do not feel they are in a test situation, but feel they are in a fun game.

The computer system to be used can be a shared central computer belonging to an institution, a shared small computer used in a department for research and teaching,a small dedicated computer with several small terminals is optimal, or the much used microcomputer.

What are the best types of questions from the computer for the physician?

A computerized patient management problem CPMP- is a simulation of the doctor patient encounter. It uses visual and audio material under computer control and the usual text displayed on the terminal. The author's voice is used to provide narrative, ask questions, give answers and elaborate on situations--it establishes limited personal contact. The tape recorder is used to respond to physical diagnosis and signs(heart sounds, etc,). X-rays, ECGS, and slides can be seen. The CPMP simulates real problems to devlop better skills and clinical judgement.

The core of the computer based multiple choice system is a question database. Each of the questions is catalogued and coded according to the subject, department, time when last used. MOst of the work is just putting the questions into the machine. The learner can select certain types of questions and answers. Here the microcomputer can be used to develop a timed answered frame.

The computer can be used as an aid to assessment for a line audit. The physician can pit his wits against an objective standard of practice devised by his peers in the privacy of his own office.

The computer can be used also as a presentation of didactic material. This can be a selection of the most recent journal articles, newer texts or a more pertinent review of the literature. This way is used to learn specific content or specific skills.

The computer plays an important role in the learning process if used in an encompassing learning environment individualized to the learner. It offers self study to learn specific content and provides immediate feedback. It records clinical experiences which can be incorporated in patient simulations or specific multiple choice questions, geared to the specific learner. It can rpovide a comprehensive literature review which ca be broadened if linked to other learning institutions. The computer can prioritized a mammoth amount of medical material, organize it, structure it to the learner. It avoids incompleteness and unnecessary duplication.

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A Comparison of Computer-Aided Drafting (CAD) and Traditional Drafting (TRAD) with respect to Achievement and Attitude.

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The subject of drafting is in a period of transition driven by new technology. The transition is from using traditional drafting equipment to using computer-aided drafting equipment. It is the belief of the researcher that students can learn the principles and concepts of drafting using a CAD system equally as well as using traditional drafting tools. A review of the literature points out that the profession is divided on this issue.

The purpose of this study was to address the question of whether or not there is a statistically significant difference between groups of students who learned drafting using traditional drafting equipment and those student who learned drafting using CAD equipment with respect to their achievement in and attitude toward drafting.

The CAD system must simply be considered a new set of drafting tools. In the case of drafting education the CAD system or computer is just a new tool to aid students in learning drafting concepts and principles. The computer as a tool for learning as opposed to computer-aided instruction (CAI) is discussed by Heermann. Heermann (1986) states that "The largest single use of the computer in colleges and universities is not computer aided instruction (CAI), as is popularly assumed; it is for word processing." The inexpensive yet powerful software programs that are constantly being developed can be used creatively to enrich the learning experience (Heermann, 1986). This software in conjunction with the computer can be used to assist the student in developing some of the skills necessary for learning the subject they are studying.

An example of using the computer as a tool for learning rather than for teaching is given by Heermann (1986) "Physics students equipped with spread-sheet programs are able to focus on the principles of physics rather than on the calculus customarily needed to learn physics. The effect is that a much wider audience of students is able to complete the course."

In this study the computer in CAD serves a similar purpose. Students who previously would not have done well in drafting because they lacked the coordination and manual dexterity skills required to letter perfectly and draw lines of the same weight no longer need to concentrate on these skills. The need for these skills is replaced by the accuracy of the computer and the consistency of the plotter thus allowing the student to concentrate on principles of drafting.

The experimental CAD sections in the study, removed the use of traditional drafting tools, and replaced them with a CAD system. The course content was not changed. The only change was in the tools utilized to solve problems and create the various drawings. Madsen (1986) stated that "This radical change in drafters' tools has brought about a change in the way they must think and work." This study demonstrates that the use of these new tools does not affect the student's ability to learn the principles and concepts of drafting.

Procedures

The study compared traditional drafting and computer-aided drafting with respect to the students' achievement and attitude. Achievement was measured using the Ohio Drafting Achievement Test and attitude toward drafting was measured on the Gable-Roberts Attitude Toward School Subjects (GRASS) measure.

The population from which the sample for this study was drawn is the School of Technology at Central Connecticut State University. The population included all students who were majoring in either Industrial Technology, Engineering Technology, Technology Education or Vocational Education. The method of sampling used was cluster sampling. The sample was drawn from six sections of TC 121 Technical Drafting during the Spring 1988 semester. Four of the six sections were used as the sample. Each section had an enrollment cap of 18 students. Registration for each of these sections was open to all students in the School of Technology. TC 121 Technical Drafting was a required course for all students in the School of Technology. Technical Drafting was a three credit 16 week course with five contact hours a week. Each section was pretested and posttested for both achievement and attitude.

In an effort to rule out the threat of instructor bias two instructors were used in the study. Each instructor taught two sections of TC 121 Technical Drafting. Each instructor taught one of the two sections using traditional drafting tools and one section using the CAD system. This assignment further eliminated the threat of instructor bias. The two instructors involved in the study were Paul J. Resetarits and John C. Larkin. Each instructor taught one section of traditional drafting and one section of CAD. The CAD system that was used consisted of CADKEY software (selected because it offered both 2D drafting and 3D modeling capabilities). The computer hardware included IBM and Zenith XT 8088 level 8 bit machines equipped with an 8087 math coprocessing chip, 640 Kilobytes of random access memory, 10 or 20 megabyte hard disk drives, EGA standard monitors providing 16 colors and 640 x 350 resolution, 11 x 11 digitizing tablets. For hardcopy output an A - B size (8 1/2 x 11 or 11 x 17) plotter was used. There were six pens available for use which were assigned to the different line types to reinforce the concept of line weight. There were 18 workstations one for each student.

The content of both the CAD and the TRAD groups was identical. The course work was also identical. Every problem which was given to the traditional group was also generated as a CADKEY part file and assigned to the CAD groups (Appendix A) . Sketching was an integral part of the learning process for both the CAD and the TRAD groups. It was felt that sketching was a quick and useful way to introduce the various projection theories utilized in drafting. The content of the course covered the following areas:

Introduction to the drafting tools
Lettering
Geometric Constructions
Multiview / Orthographic Projection
Sectional Views
Auxiliary Views
Dimensioning
Tolerancing
Threads and Fasteners
Working Drawings
Isometric Projection
Oblique Projection
One and Two Point Perspective
Three Dimensional Modeling

In support of the drafting concepts and principles the textbook Technical Drawing eighth edition by Giesecke, Mitchell, Spencer, Hill, Dygdon was used. This classic text covers in detail all of the drafting concepts, principles and practices which were the main objectives of the course. A second textbook was required to cover the CAD aspect for the experimental sections. The CAD text selected was Using CADKEY by Resetarits and Bertoline. This text served as a reference to the students, which covered the details of the operation and the idiosyncracies of the CAD system. The cost of the additional text was justified by the fact that the students did not have to buy any drafting equipment. The TRAD group had to purchase $40.00 worth of drafting tools to complete the assignments given in the course.

A quasi-experimental design was utilized for the study. The Nonequivalent Control Group Design which is Design 10 from Campbell and Stanley (1963) was used. This design includes an experimental and a control group which are administered both a pretest and a posttest but the two groups do not have pre-experimental sampling equivalence. The control group was the sections using the traditional drafting tools and the experimental group was the sections using the CAD system. The data collected were analyzed using a powerful parametric statistical technique, a two-way analysis of covariance (Two way ANCOVA). After covarying out the pretest scores, the group means on the dependent variables were compared. No Significant difference ($p = .05$) was found between any of the sections for either achievement or attitude.

The instrument which was used for both the pretest and the posttest is the Ohio Drafting Achievement Test Part 1. This test has a 1986 copyright and is edited and distributed by Instructional Material Laboratory, Vocational Education, The Ohio State University, College of Education, Columbus, Ohio 43210. The Ohio Drafting Achievement Test is a multiple choice test. The instrument used to measure the students' attitude toward drafting was the Gable-Roberts Attitude Toward School Subjects (GRASS).

Findings

The findings of the study are based on the following hypotheses. In all cases the hypotheses were tested after adjusting for initial differences.

H_O1 There will be no significant difference between the traditional drafting group and the computer-aided drafting group with respect to drafting achievement.

Analysis of the data indicated that the researcher would fail to reject null hypothesis one, since the data from the study did not provide a significant F ratio when an ANCOVA was run to test this hypothesis. Students in both the TRAD and the CAD groups obtained similar achievement scores on the Ohio Drafting Achievement Test.

H_O2 There will be no significant difference between instructor 1 and instructor 2 with respect to drafting achievement.

Data analysis indicated that the researcher would fail to reject null hypothesis two. The data from the study did not provide a significant F ratio when an ANCOVA was run to test this hypothesis. Students in both the instructor 1 (Resetarits) group and the instructor 2 (Larkin) group obtained similar achievement scores on the Ohio Drafting Achievement Test.

H_O3 There will be no significant interaction between instructors and method of drafting with respect to student drafting achievement.

The results of the data analysis indicated that the researcher would fail to reject null hypothesis three. The data from the study did not provide a significant F ratio when an ANCOVA was run to test this hypothesis. The interaction between the independent variables of Method of Drafting and Instructor was not significant.

H_O4 There will be no significant difference between the traditional drafting group and the computer-aided drafting group with respect to attitude toward drafting.

The data generated from the study indicated that the researcher would fail to reject null hypothesis four. The data from the study did not provide a significant F ratio when an ANCOVA was run to test this hypothesis. Students in both the TRAD and the CAD groups provided similar attitude scores on all three factors of General Interest, Usefulness, and Relevancy on the GRASS attitude measure.

H_O5 There will be no significant difference between instructor 1 and instructor 2 with respect to student attitude toward drafting.

The data analysis indicated that the researcher would fail to reject null hypothesis five. The data from the study did not provide a significant F ratio when an ANCOVA was run to test this hypothesis. Students in both the instructor 1 (Resetarits) group and the instructor 2 (Larkin) group provided similar attitude scores on all three factors of General Interest, Usefulness, and Relevancy on the GRASS attitude measure.

H_O6 There will be no significant interaction between instructors and method of drafting with respect to student attitude toward drafting.

Analysis of the data indicated that the researcher would fail to reject null hypothesis six. The data from the study did not provide a significant F ratio when an ANCOVA was run to test this hypothesis. The interaction between the independent variables of Method of Drafting and Instructor was not significant.

Conclusions

With CAD having a greater impact on the drafting process in industry, more effective ways of teaching CAD in a drafting class must be explored. This study offers valuable information on a subject that is often debated. Many drafting instructors feel that students must learn traditional drafting prior to learning CAD. The results of this study indicate that there is no significant difference in achievement or attitude between students who learn drafting by the TRAD or the CAD method. Student can learn the principles and concepts of drafting while using a CAD system rather than traditional equipment. The results of the study demonstrate that beginning students in drafting who use CAD will achieve at an equal rate of success in comparison to students who use traditional drafting tools.

Having empirical data indicating that students do not have to learn traditional drafting before they learn CAD will change instructors approaches drafting education in the future. Now instructors can spend less time emphasizing the traditional tools and skills for drafting and spend more time on the drafting concepts and CAD competencies required by industry today. CAD is a technology that is here to stay. It is time for drafting educators to greet CAD with open arms and teach their students the skills required in industry today. The significance of this study will impact the School of Technology at Central Connecticut State University and potentially many other Schools of Technology across the country. In the near future at least 75% of the time in TC 121 Technical Drafting will be spent using the CAD system. Twenty five percent of the drafting class will still be spent on sketching and traditional drafting so that if students goes to work for a company who has not yet made the transition to CAD they will still have the ability to function on a drawing board. Teaching drafting using a CAD system will eliminate the requirement of a separate CAD course and allow room for another course to be added to the student's major.

Recommendations

The recommendations which follow were formulated by the researcher based upon knowledge gained during the development, execution, and evaluation of the experiemental education program. The recommendations take into account observations and statistical findings from the study. The recommendations are:

In four year college technology programs of study where there is only a single drafting course, or in cases where there is a drafting course and a separate CAD course required there should only be a single drafting course which spends at least 75% of the class time using the CAD system to complete drafting assigments. The remaining time should be devoted to a unit which studies the use tradtional tools and sketching.

The use of the CAD system should be integrated into future courses within students major area or concentration to reflect the use of the electronic database which has been created. In the design analysis area the model created using CAD can be tested for stress and other characteristcs with the aid of finite element analysis software. The CAD database can also be used to manufacture the part withthe aid of CAM software. The uses and applications of CAD will continue to grow and require drafting instructors to keep a breast of the new developments.

It is highly reccommended that a one student per CAD system ratio be used. This can be achieved by not buying the latested and greatest computers if a budget is limited. Instead purchase the tried and proven turbo XT clone computer with a mouse and a monochrome monitor, and a budget will go much further this way.

Develop tests to be given on the computer in class. This serves as a quick check to make sure that students are doing their own work and also allows the instructor to identify which students are having problems.

The most important recommendation is to drafting instructors who have not yet integrated CAD into their drafting curriculum. The time is now to make the change to CAD. It will breath new life into the drafting program, students and Faculty!

Recommendations for Future Research

1. One recommendation is that this study be replicated in drafting programs at different levels of education such as junior high school, high school, vocational school, two-year technical college, Community college and junior college.

2. This study should also be replicated using other types of CAD systems. Other possible micro-computer based software that could be used would include AutoCAD, Drafix, MicroCADAM, Microstation, and VersaCAD. On the mini-computer and mainframe computer levels Anvil, ComputerVision, Intergraph, McDonnel Douglas and Medusa are possible CAD systems that could be used to replicate this study.

3. The variable of time is another valuable consideration in the debate between TRAD and CAD. While time was not one of the variables included in the study the researcher did run several timed tests at the end of the study. One problem was given as an isometric drawing and had to be drawn orthographically to include the front, top, and right side view. The mean of the CAD group was about 2 minutes less than the TRAD group. The other timed problem was presented as an orthographic drawing and had to be completed as an oblique projection. This time the CAD group was considerably faster.

4. The transfer of knowledge from TRAD to CAD and CAD to TRAD is another area of interest that warrants further study. After the study was completed the treatments were reversed. That is the CAD group generated drawing using traditional tools and the TRAD group generated drawings using CAD. The researcher observed that the transition from CAD to TRAD was much easier. The students were already familiar with how to use the traditional tools from previous life experiences. The students quickly and accurately put their understanding of drafting principles and concepts to practice with paper and pencil.

THE EFFECTS OF CALCULATORS AND COMPUTERS ON THE MATHEMATICS CURRICULUM

K. A. Maury Berwanger

ABSTRACT

When calculators and computers are available in classrooms, they often effect the content of the mathematics curriculum. Research indicates that in technology-rich environments, mathematical skills which lend themselves to machine execution become devalued. In these classrooms, machines assume the role of executing mathematical algorithms, and the humans spend their energies on other tasks.

Many believe the idea of the effective procedure may be the most important idea of the 20th century. However, it may be important for reasons that are not well understood and also are well beyond the obvious. The effective procedure (because it is machine executable) may actually provide educators with the power to choose the mathematics that is worth human mental energy. Research indicates that school personnel will devalue those algorithms that can be written as effective procedures, stored as effective procedures, and made accessible to teachers and students in school. Teachers then decide that these algorithms are no longer worth human energy, and drop or deemphasize them from the school mathematics curriculum. In their place, teachers substitute other topics. In effect, humans have developed effective procedures and machines that will store and execute these procedures, and are spending less instructional time teaching humans to execute them. Instead, instructional time is devoted to other things.

If these trends continue, we may see a mathematics curriculum quite different from the traditional one we've come to know. The change may not reside in the quality, the quantity, or the style of teaching or learning. The change may not reside in the things of schools, the tools, or the general appearance of schools or classrooms. However, the people may be doing different things, the nature of what they are doing may be different, and the purpose of what they are doing may change. The most important change wrought by machines may lie in what the people choose to do with their energies and time, along with the definition of and the value placed on human intelligence.

INTRODUCTION

Educators often discuss the need for curriculum change. Some feel that change is needed while others believe that change is unnecessary. Often, those who use technology are in the first group. For this project, mathematics teachers were surveyed to determine how technology had changed their curriculum. The participants reported that many changes had occurred because of technology use. The purpose of this paper is to discuss how calculators and computers change the mathematics curriculum. First, the specific levels of impact of technology on the mathematics curriculum are discussed. Second, the specific topics, concepts, and skills which teachers reported changed within the standard mathematics curriculum are reviewed.

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THE LEVELS OF IMPACT

The participating teachers could be categorized into three levels of impact. Low impact teachers reported no curriculum change, high impact teachers reported significant curriculum change, and medium impact teachers reported a level of change between the two extreme groups. Within the low impact group, there were two discernable levels of use. The first group used technology consistently but did not report any curriculum change. These teachers used calculators or computers to do tasks which did not effect the curriculum. Typically, they reported using calculators to check pencil and paper algorithms or computers to deliver arithmetic drill and practice. These teachers were consistent users of computer courseware developed for the purpose of providing students with computer-assisted drill and practice in the basic arithmetic facts. The second group of low impact teachers did not use either technology, and did not report any curriculum change. None of the teachers in the low impact group reported curriculum change due to either the computer or the calculator.

High impact teachers reported consistent use of both calculators and computers, and also reported curriculum change that had occurred because of technology use. These teachers taught two types of courses. Some of the courses they reported teaching were courses which likely would not have existed within the secondary school mathematics curriculum before calculators and computers, while other courses were more traditional within the secondary school curriculum.

Among the classes taught that likely would not have existed before calculators and computers were Computer Math, Probability and Statistics, Math with Computers, Digital Structures, Discrete Math, and Algorithmic Modeling. Several respondents reported that some of these courses were developed for the purpose of preparing mathematics students for careers in the sciences. One such course uses mathematics to model a wide variety of both discrete and continuous phenomena, assumes easy access to calculators and computers, emphasizes the study of families of elementary functions, includes a unit on data analysis, and another on the inexact nature of numerical algorithms that are implemented on calculators and computers.

Exactly one half of the high-impact consistent technology-using respondents reported using computers on a daily basis to teach courses directly or indirectly related to computer use within applied mathematics. Computer Mathematics, Business Mathematics, Remedial Mathematics Using Computers, Consumer Mathematics, and Vocational Mathematics are examples of the courses they reported teaching. Each of these respondents reported using computers for individual or small group student work, and each reported that the classes met in a computer lab with enough computers available to accomodate one-half of the students at any one time. The other high-impact consistent technology-using respondents reported that they used computers once or twice a week to demonstrate theoretical mathematical concepts to large groups of students during lectures. These teachers reported that they used a computer as a large group demonstration tool to teach topics such as algorithmic modeling, function modeling, function analysis, variance, recursion, and rotation. None of these teachers reported that they taught with or about calculators. Rather, their students used calculators to perform the basic arithmetic and scientific functions found on the typical hand-held calculator.

THE IMPACT OF CALCULATORS AND COMPUTERS ON THE MATHEMATICS CURRICULUM

Teachers were asked to identify those topics, concepts and skills which had been added to, dropped from, or changed within the mathematics curriculum because of the calculator or the computer. Some topics received increased emphasis while others were devalued. That is, they were dropped from the curriculum or received less classroom emphasis.

Among those which received increased emphasis were mathematics concepts, problem solving, graphing, programming, calculator use, percent applications, money applications, and estimation. It is noteworthy that while some of these topics and concepts are directly executable with a hand held calculator or desktop microcomputer, the majority are not machine executable. Some represent tasks that the machine can do, while others represent tasks that machines cannot do. However, it appears that the majority of responses represent tasks that the machine cannot perform. It would appear that in a technology-rich environment, those tasks which machines cannot do receive increased emphasis.

Also, the high impact teachers were asked to identify those topics, concepts and skills which were dropped or deemphasized because of the calculator or the computer. Twenty-two respondents stated that interpolation had been dropped from the curriculum, along with forty respondents who reported that the reading and use of logarithmic and trigonometric tables had been dropped from the curriculum. It appears that students and teachers use their calculators to regenerate the needed values for trigonometric functions rather than use printed mathematical tables. Calculator users appear to use their calculators as mathematical data basis, simply requesting values to be recalled when they are needed. This instant recall of a needed value has eliminated the need to interpolate. Similarly, the study of logarithms has disappeared in many classrooms because students are able to regererate most of the needed higher powers and most of the exponential functions with their hand-held calculators.

Finally, forty-eight respondents stated that various arithmetic algorithms had been dropped from the curriculum. Often mentioned were the square root algorithm, the logarithmic calculations, and the basic arithmetic algorithms. Active technology-using teachers reported dropping long division, long multiplication, fractions, decimal multiplication, and decimal division from the curriculum. Some of these teachers reported that there was less class and homework time spent on performing the basic arithmetic facts.

Most of the topics, concepts, and skills which were reported dropped from the mathematics curriculum were those that the calculator easily performs. It appears that active technology-using teachers are devaluing those topics, concepts and skills which machines can do. These teachers reported that more emphasis was placed on mathematical concepts and less emphasis was placed on arithmetic computation and symbol manipulation when calculators and computers were consistently used.

SUMMARY

The levels of impact of technology on the mathematics curriculum were discussed. The levels of impact included two categories of low impact and two categories of high impact curriculum change. The low impact groups included teachers who consistently used technology, and teachers who did not use technology. Similarly, the high impact groups included teachers who used calculators and computers consistently, and teachers who did not use either machine.

Also, those specific topics, concepts, and skills that teachers reported changed within the mathematics curriculum because of calculators and computers were reviewed. Teachers reported dropping or deemphasizing algorithms which machines can do. THey also reported increasing the importance of concepts, topics and skills that machines cannot do.

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APPROXIMATE ANALYSIS SYSTEM OF INSTRUCTION PROGRAMS

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ABSTRACT

We would analyze instruction structure of a subject matter and construct its effective program by applying the fuzzy theory. We recently have developed the analysis method which could approximately calibrate the connective flows among conceptual nodes based on test data. In order to proceed the data analysis accurately and quickly, the computer support system has been developed and effectively utilized among us. In this paper, we would discuss the theoretical explanation of the analysis system and present the case study in mathematics program.

INTRODUCTION

We would verify and/or modify the instruction structure of a subject matter by applying the fuzzy theory. We recently have developed the analysis system based on the test data which is effectively utilized among us, and we would explain the analysis system and present the instruction effectiveness concerning mathematics.

ANALYSIS METHOD

We represent the test data as n x N binary matrix $X = (x_{uv})$, where $x_{uv} = 1$ if the student u passed the test-problem v and $x_{uv} = 0$ if he failed it. The contingency table of the test-problem P_i and P_j is shown in Fig. 1, where a is the number of the "passers" of both P_i and P_j, d is the number of the "failures" of both P_i and P_j, and so on.

i \ j	1	0	total
1	a	b	a + b
0	c	d	c + d
total	a + c	b + d	n

Figure 1 Contingency Table

If P_i is prerequisite to P_j, then c in Fig. 1 should be relatively small, and both $a/(a + c)$ and $d/(c + d)$ would be nearly equal to 1. Thence, we could consider a relation index from P_i to P_j.

Definition 1 $r_{ij} = \lambda a/(a + c) + \mu d(c + d), \lambda + \mu = 1$ (1)

where $r_{ij} = 1$ if $(a + c)(c + d) = 1$. Nextly, if we consider the distribution of the responders, then λ would be $(a + c)/((a + c) + (c + d))$, and we could define the relation index from P_i to P_j.

Definition 2 $t_{ij} = (a + d)/((a + c) + (c + d)) \in [0,1]$ (2)

where $t_{ij} = 1$ if $b = n$.

If t_{ij} is nearly equal to 1, it means the connective flow from P_i to P_j is strong. If t_{ij} is nearly equal to 0, it means the flow is weak, and if t_{ij} is nearly equal to 0.5, it means the flow is fuzzy. Thus, we could have a connective flow graph $\underline{T} = (\underline{t}_{ij})$ by giving $\underline{t}_{ij}$ to the arc from P_i to P_j as the fuzziness of the connectivity. The fuzzy graph $\underline{T}$ shows the degree of instruction flows among the test-problems based on the learning data.

The graph $\underset{\sim}{T}$ is so complicated that we would simplify it, approximately. We define the p-graph $\underset{\sim}{T}^P$ of a fuzzy graph $\underset{\sim}{T}$ for $0 \le p \le 0.5$, which roughly shows us the crisp and fuzzy flows among the nodes.

Definition 3

$$\underset{\sim}{T}^P = (\underset{\sim}{t}^P{}_{ij}),\ \underset{\sim}{t}^P{}_{ij} = \begin{cases} 1 & (\underset{\sim}{t}_{ij} > 0.5 + p) \\ 0 & (\underset{\sim}{t}_{ij} < 0.5 - p) \\ t_{ij} & (\text{otherwise}) \end{cases} \qquad (3)$$

We could generally define the relative Hamming distance between $\underset{\sim}{T}$ and $\underset{\sim}{T}^P$, and have the related theorem.

Definition 4 $$d(\underset{\sim}{T},\underset{\sim}{T}^P) = \sum_{i,j} |\underset{\sim}{t}_{ij} - \underset{\sim}{t}^P{}_{ij}| / (n^2 - n) \qquad (4)$$

Theorem 1 $$p \uparrow 0.5 \Rightarrow d(\underset{\sim}{T},\underset{\sim}{T}^P) \downarrow 0 \qquad (5)$$

$\underset{\sim}{T}$ and $\underset{\sim}{T}^P$ is considered to be similar if $d(\underset{\sim}{T},\underset{\sim}{T}^P) < \epsilon$, where ϵ could be 0.2 by the fuzzy decision.

According to the theorem 1, for any $\underset{\sim}{T}$ and $\epsilon > 0$, there exists a $\underset{\sim}{T}^P$ with $d(\underset{\sim}{T},\underset{\sim}{T}^P) < \epsilon$ if P is suitably chosen. Among such P's, let π be the minimum value, and we call $\underset{\sim}{T}^\pi$ the approximate p-graph of $\underset{\sim}{T}$.

Definition 5 $$\underset{\sim}{T}^\pi : \pi = \mathrm{Min}\{P : d(\underset{\sim}{T},\underset{\sim}{T}^P) < \epsilon\} \qquad (6)$$

$\underset{\sim}{T}^\pi$ is the fuzzy graph which is not only similar to $\underset{\sim}{T}$ but also is the simplest graph representing $\underset{\sim}{T}$. For further denoting, we define the approximate ternary graph $\underset{\sim}{T}^*$ of $\underset{\sim}{T}$.

Definition 6

$$\underset{\sim}{T}^* = (\underset{\sim}{t}^*{}_{ij}),\ t^*{}_{ij} = \begin{cases} 1 & (t_{ij} > 0.5 + \pi) \\ 0 & (t_{ij} < 0.5 - \pi) \\ \alpha & (\text{otherwise}) \end{cases} \qquad (7)$$

where α implies the fuzzy connective flow from P_i to P_j. For any $\underset{\sim}{T}$ and $\epsilon > 0$, there exist the approximate ternary graph $\underset{\sim}{T}^*$ of $\underset{\sim}{T}$.

Theorem 2 $$\forall\ \underset{\sim}{T},\ \epsilon > 0 \Rightarrow \exists\ \underset{\sim}{T}^*$$

We have the approximation algorithm (Yamashita's Algorithm) to obtain $\underset{\sim}{T}^*$ from T.

(a) Let p be 0, construct the initial p-graph $\underset{\sim}{T}^P$ of $\underset{\sim}{T}$ and go to (b).
(b) If $d(\underset{\sim}{T},\underset{\sim}{T}^P) < \epsilon$, then go to (d), else go to (c), where $\epsilon > 0$.
(c) Increase p by $d > 0$, construct the new $\underset{\sim}{T}^P$ of $\underset{\sim}{T}$ and go to (b).
(d) Construct $\underset{\sim}{T}^*$ from $\underset{\sim}{T}$.

The approximate graph $\underset{\sim}{T}^*$ represents the global feature of the learning process of the students and we could investigate instruction program by comparing the instruction hierarchy graph I with it.

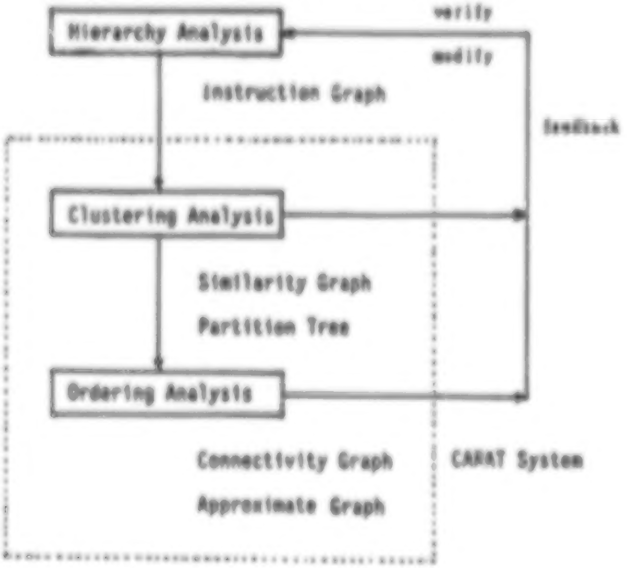

Figure 2 Analysis System

Concerning these analysis, we need a great amount of data processing. In order to conduct the data analysis accurately and quickly, we have developed the computer support system CARAT which is effectively utilized among us.

CASE STUDY

We would present a practical application to the high school mathematics. The analysis frames are the followings.

(1) We clarify the prerequisite relation among the conceptual nodes, construct the hierarchy structure graph I and lecture in the classroom.

(2) We edit and execute the suitable test, analyze the test data and construct the connectivity structure graph $\underset{\sim}{I}$.

(3) We construct the approximate ternary graph $\underset{\sim}{I}^*$ of $\underset{\sim}{I}$. By comparing I with $\underset{\sim}{I}^*$, we could verify/modify the instruction program.

As a case study, we would present the analysis concerning quadratic equation, inequality and curve shown in Fig. 3(a), where D is the discriminant. We lectured, edit and executed the test and analyzed the test data. We obtained the connectivity graph $\underset{\sim}{I}$ in Fig. 3(b) and its approximate graph $\underset{\sim}{I}^*$ in Fig. 3(c).

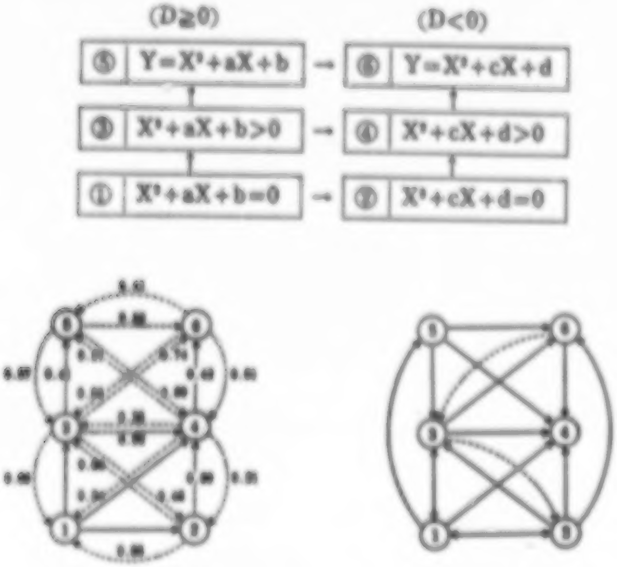

Fig. 3 (a) Graph I, (b) Graph $\underset{\sim}{I}$ and (c) Graph $\underset{\sim}{I}^*$

By comparing I with $\underset{\sim}{I}^*$, we could obtain the following information.

(A) We could verify the flow ($D \geq 0$) ($D < 0$), since there exist 1 → 2, 3 → 4 and 5 → 6.

(B) We could verify the flow (equation) → (inequality), since there exist 1 → 3 and 2 → 4.

(C) We could verify the flow (equation) → (curve), since there exict 1 → 5 and 2 → 6.

(D) We could find the strong flow (curve) → (inequality), since there exist 5 → 3 and 6 → 4 in T^*, respectively.

Considering the results, the program (equation) → (curve) → (inequality) would be more effective than that in Fig. 3(a), since the instruction structure could be made to resemble the learning process.

Next year, we modify the instruction program and obtained the better achieving results as shown in Fig. 4, especially as to problem 4 and 6, which is the evident effectiveness of our analysis consequence.

	1	2	3	4	5	6
1st year	98	88	79	41	82	62
2nd year	97	90	81	68	87	77

Figure 4 Test Scores

CONCLUSION

We have discussed the analysis system in order to verify/modify the instruction program, and the results are also useful for CAI courseware design. Although the case study is experimented in high school mathematics, the analysis method supported by the CARAT system is available for the arbitrary subjects.

ACKNOWLEDGEMENTS

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COMPUTER MODELING OF HUMAN PERSONALITY CHARACTERISTICS

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21606

ABSTRACT

Educational and clinical researchers confront many issues which our counterparts in the physical sciences seldom encounter. In some instances, there are ethical questions in withholding needed interventions to obtain a control group. In rehabilitation research, with some handicaps there is a practical difficulty in finding sufficient sample size for traditional statistical analysis. Some resolution may be found in programming a computer to "behave" in accordance with predetermined personality characteristics. For the simulated experiment, the researcher would identify the traits expected to have effect on some behavior, determine the behavior probability with different combinations of traits and program the computer for equivalent responses. When an intervention effect on the traits can be predicted from results of previous research, that effect can be added to the data base and experimental outcome can be simulated. Data obtained in pilot study support the plausability and efficacy of this proposed model.

INTRODUCTION

A model (ref 3) has been proposed in which personality trait theory, probability theory, and computer resources are combined to simulate the conduct and outcome of a research study on the effects of therapeutic interventions. To use this model, the researcher needs a means to assign a probability to a subject's behavior, the results of previous research from which to project simulation outcomes, and an existant data base from which samples can be drawn. This paper is report of a pilot study testing the efficacy of the model.

For this pilot study, the data base was comprised of test results on Cattell's Sixteen Personality Factor Questionnaire (16PF) gathered over a period of years for diagnostic use. The 16PF (ref 1) meets two essential needs for the computer simulation. It measures primary personality traits from which probable behaviors can be inferred, and it has frequently been used to obtain pre/post test results for a variety of experimental interventions.

PROCEDURES

The following scenario was created for this simulation. A client enters a crowded waiting room. There will be room for the client to sit if s(he) asks someone to move over and make room. The dependent variable is the experience of anxiety elicited in the client by the behavior response in the scenario.

For this simulation, it was assumed that the probability of the client's requesting someone to move could be predicted by the

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combination of 16PF traits designated as extraversion. There are a number of techniques from which a behavior probability could be extrapolated from the extraversion score, but for the sake of simplicity in this study, the probability was assigned in reference to the normal curve. Referring to that curve, the scaled scored (sten) obtained from the 16PF of 8 represents a percentile of 90. For the simulation, it was thus assumed that if a subject had an extraversion score of 8, the behavior of initiating a conversation would occur with a probability of .9 or 90 times in 100. In like manner, the 16PF anxiety scale was used to obtain the general probability of an anxiety response. Finally, the probability of a positive response by the unknown party to the subject's request for that party to move was assigned as .5, or 50 in 100.

To illustrate the rationale, assume a hypothetical subject whose extraversion score is 8 and whose anxiety score is 3. The probabilities assigned from the normal curve are .90 and .11, respectively. Thus, in the experimental situation as defined, the client would be expected to make the request 90 times in 100. If the request is not made, the client would experience anxiety from failure to request the move, 11 times in 100. If the request is made, a positive consequence from the other person would occur 50 times in 100. If the consequence is positive, no anxiety is predicted. If the other person does not respond positively, an anxiety response in the client would again be predicted at a rate of 11 times in 100.

With the above rationale, I prepared a BASIC program to read the data file of 16PF scores and select a sample of subjects whose scores indicated emotional difficulties, operationally defined as neurosis prediction above 7.0 (ref 1). For this sample, the program then calculated the extraversion and anxiety scales, and assigned the behavior probabilities as described above. Ten subjects each were selected for the control and two treatment groups. Each of the subjects was given ten "trials" and the total number of anxiety responses predicted from those trials was summed and averaged.

Intervention effects for the two treatment groups were obtained for the effects of general counseling (ref 2) and for personality change as a result of physical fitness training (ref 4). The same thirty subjects were then selected from the data file. The control group's 16PF scores were unchanged. The two treatment groups's scores were modified using the average change data from the above studies. Extraversion and anxiety probabilities were re-calculated, and the trials run again.

RESULTS

In this simulation, there were ten subjects in each group and each subject was given ten "trials", ten simulated situations in which anxiety could be created by the behavior in the crowded waiting room. Table 1 reports the mean number of anxiety responses for the group with no intervention, the simulated counseling intervention, and the simulated effects of physical fitness training. These means were adjusted for pre-treatment differences among the groups.

Table 1 Mean anxiety responses for control and two treatment groups
Ten subjects per group; ten trials per subject

	counseling intervention	fitness intervention	control group
adjusted mean number of anxiety responses	1.2	2.8	3.7

The final step in the program was to calculate a traditional analysis of covariance, reported in Table 2. Those data indicate that in this simulation, general counseling was significantly more effective than either physical fitness training or no intervention in reducing anxiety for this sample of subjects.

Table 2 Analysis of Covariance

Source of Variation	df	SSx	SSy	Sxy	SSy.x	Vy.x	SDy.x
Among Means	2	7.3	48.9	18.8	29.6	14.8	
Within Groups	26	132.1	108.5	68.8	72.7	2.8	1.7

$F_{y.x} = 5.29$, $p < .05$

Significance of Mean Differences in Anxiety Responses:
fitness group vs. control group, $p > .05$
counseled group vs. control group, $p < .01$
counseled group vs. fitness group, $p > .05$

DISCUSSION

I do not suggest that the outcome of this procedure is identical to the results obtained from an experiment actually conducted with human subjects. The validity of the procedure rests in large part on a number of experimental assumptions. However, I would emphasize that all experimental data rests on some assumptions of the researcher, and the simulation procedure forces such assumptions to be made apparent. If the researcher or the critic is not comfortable with the probabilities assigned to the behaviors, that researcher has the luxury of running the simulation with a variety of different behavior probability assumptions, and comparing the results. Each simulated experimental run can be completed in less than ten minutes.

The researcher also has increased discretion in the characteristics of subjects selected for experimentation. Given an appropriate data base, the researcher can select samples with physical impairments, by gender, by age, and so forth. The effects of therapeutic intervention in this study were based on samples of individuals selected to have apparent emotional difficulties. When the same simulation was run selecting samples without the criteria of emotional difficulty, there was no difference among the treatment and control groups in mean anxiety responses in the waiting room scenario.

As noted above, for simplicity in the pilot study only two 16PF scores, extraversion and anxiety, were used to assess behavior probabilities. Further investigation of this model includes the use of a broader number of scores and the effect of means other than the normal curve to assign behavior probabilities. A study for direct contrast of the simulation and an actual experiment is also being planned.

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A VIDEODISC WORKSTATION and PRODUCING AN INTERACTIVE APPLICATION

Edward A. Imbier*, Karen Price°, Tobia Imbier^

ABSTRACT

The building blocks for an effective, interactive, integrated, under $2000-$3000 videodisc workstation are becoming a reality. It has been our dream to deploy such a system and to produce our own low budget courseware, including scripting, shooting in S-VHS, pressing a videodisc, and authoring. From dream to hardware and from script to screen, this paper describes the journey in the making of an ESL application.

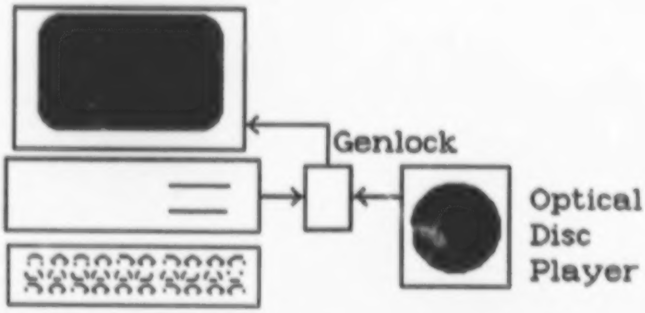
INTRODUCTION

Technical considerations, time-consuming programming, and cost barriers prevent most educators from producing and deploying their own interactive multimedia courseware. A single multimedia student workstation can cost thousands of dollars.

Many applications could use a multimedia platform and format for interactive, individualized instruction. Developing English language skills is one such application. The Massachusetts Bureau of Adult Education reports that some 200,000 immigrants have arrived in the state since 1980, many of whom require adult education. Nationally, for more than 20 million people, English is not the language spoken at home.

THE MULTIMEDIA PLATFORM

Important elements of an interactive system are the following:
1. Screen icons and buttons for authoring and student control.
2. Text and graphics on the same monitor as video images.
3. Control of still and motion video/audio source devices.
4. Record keeping of student responses.
5. Linking of multimedia segments.
6. Time between a student response and new visual or audio material under two seconds.



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More popular training platforms are configured around IBM compatibles, Macintosh SE or II, or Apple II computer systems. Our run-time system, or training platform, is the less expensive Amiga 500, configured with 1MByte of memory, dual floppies, and a genlock mounted on its RGB video output port. The genlock device converts the RGB computer video signal to composite video, synchronizes it with external video from an external optical disc player, and overlays the computer video output on the external video signal. Workstation cost, including monitor, genlock, and videodisc player, can be under $2000.

The VIVA icon-based authoring software by *Knowledgeware* is being used for courseware development, i.e. for designing a sequences of events to occur in response to student-made choices from menus, questions, and graphic screens. These events may be new screens of text, graphics, and video, or the sound of audio tracks. Images or information may be linked to new images or information. Students will hear and see real people and places on same monitor as the computer text and graphics.

ALTERNATIVES FOR LOW COST PRODUCTION

Producing a videodisc is usually thought of as being cost prohibitive. However, shooting in the S-VHS video format maintains the same 400 lines of resolution that optical videodisc players can produce. A time-coded 1" or 3/4" videotape is a necessity for optical disc mastering. Thus, S-VHS video must be dubbed to one of these larger formats.

If optical disc video still frames are required as part of future courseware, costly broadcast quality editing may be required to make proper frame servo edits. Wrong A/B field recordings will be occur 50% of the time using conventional video editing equipment, resulting in jumping still frames on the student video monitor. This problem may be solved by recording at least three successive video frames and selecting a middle frame for viewing. If this can be tolerated, then video editing can be performed with a consumer/industrial grade VCR outfitted with flying erase heads. (Many VCR's now include this feature.) The disc mastering facility can also fix faulty A/B field recordings if the facility is provided with a list of the problem segments.

A preliminary check videodisc costs between $300-600. If only one disc is needed, then authoring can begin immediately.

It should also be noted that an optical disc holds two independent audio channels. Therefore, two different soundtracks may be associated with any video segment.

THE APPLICATION

The challenge is to create a multisensory and situational experience, which includes print, aural, and video sources, to develop language skills in students who use English as a second language. To make learning an involving experience, the multimedia workstation which is described above is to be used by a student to listen to videotaped opinions and perform various activities regarding data taken from actual opinion polls. Through repetition, paraphrasing, and interpretation, a student interacts with opinions of a representative group of individuals. On-screen buttons are used by students to make menu selections of topics and issues, and student responses and choices may be stored and analyzed. The system can also suggest selected tasks or pathways for a particular student or for specific target populations.

Tasks a student may be involved with include the following:
1. The student indicates his/her opinion.
2. The student tries to guess the overall U.S. opinion.
3. The student tries to predict the respondent's opinion from stills or a short introduction.
4. The student's opinions and demographics are stored for later analysis.

This application is modular and task-based. The same video materials serve students at differing competency levels. Students are challenged to assess and interpret sociolinguistic information, cultural information, grammatical and lexical information.

THE FUTURE

Interactive multimedia delivery systems should become more widespread and integrated. For instance, CVD optical drive units are being designed to occupy the space of a hard disk drive or 5 1/4" floppy drive.

No 3 - TECHNOLOGY: EDUCATIONAL RESEARCH vs. INSTRUCTIONAL RESEARCH

Presenter: Don Stewart,

1.0 The Two Types Of Teaching/Learning Research

1.2 First - Traditional Educational Research Where Learning Is The Dependent Variable

Most traditional educational research is concerned with the comparing of various methods of teaching (*usually presenting*). This makes the methods as the independent variable and time as the constant. The implied goal of educational research is the finding of the one best method for everyone in spite of the fact that all educators agree that no one method will work for all students.

1.3 Second - The NEW INSTRUCTIONAL Research Where Learning Is The Constant

The new instructional research will be concerned with finding whatever combination of methods, media and technology will achieve Instructional Excellence wherein 90 percent or more of the students will be achieving 100 percent of their unit and course objectives. In this type of research, the methods used are the independent variables and time is considered as the dependent variable:

2.0 Traditional Educational Research on Technology

Although research in most fields have advanced the skills and knowledge in those fields and the loss of that research would really cripple the progress in those fields, there have been several education writers who have stated that if years of educational research were lost, the educators and education would go on as usual. J. M. Atkin in the Journal of Research in Science Teaching stated that *"An elaborate research methodology has evolved around the investigation of inconsequential events."*

2.1 Educational Technology Research - Presenting Teachers vs.Presenting Technology

There has been literally thousands of research studies of this type in which the traditional presenting teachers have been pitted against some form of technology. About two thirds of these studies have resulted in "*no significant differences*" between the two presentations.

2.1.1 From the Traditional Teachers' Viewpoint - Technology Should Be Used as a Supplement

Believing that the traditional role of the teacher as the presenter of the course content is the most important, the traditional teacher looks at these research results and says, *"These results prove that technology is not any better than teachers so let the teachers continue to perform their traditional role and if technology is to be used, it has to be as a supplement to the teacher and it cannot be used to REPLACE the current role of the teacher."*

2.1.2 From the Technologist's Viewpoint - Technology Should Be Used as a Replacement

Teachers who are interested in improving student learning look at the same results and say, *"These results prove that technology is just as good as the teachers so why not let the technology REPLACE the traditional role of the teacher in the classroom and release the teacher to individualize student learning."*

3.0 The Problems with Traditional Technology Research

If educational research is not proving to be of much value to the teachers in the classroom, there has to be some reasons for this problem. A large part of the problem is with the educational research itself and another part of the problem is with the classroom teachers.

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(For more information, visit the ICAT/SLATE booth in the exhibit area)

3.1 Designed Results

The next most serious problem concerns several of the factors involved with setting up the research in which subjective decisions can be made that will design the results of the research into the study before the actual research starts. Then the results of the research are subjected to statistical manipulation. However, the early subjective decisions result in the computer problem of GIGO (***Garbage In - Garbage Out***).

3.1.1 The Researchers' Freedom to Select Subject Matter

In preparing to do educational technology research, the selection of the subject matter area to be used in the research can affect the outcome of the research because some subject areas may benefit from the use of certain types of technology and some other subjects may benefit from other types of technology.

"Best Case" Subject Matter - Non Problems - Frequently, the researcher will select a unit for the research which the researcher knows very well because it will save development time for the researcher. If the researcher knows the area well and probably already teaches it well, it is a "***non-problem***". Comparative research using this "***non-problem***" will most likely result in "***no significant differences***". Research is supposed to deal with problems not with non-problems.

3.1.2 The Researchers' Freedom To Make the Test

In most research, the researcher is free to make up the test used in the research. Just like the results are designed into standardized tests, the researcher can design the results into the test used in the research.

The Subjectively Written "*Objective*" Type Test Items - Most tests used in research are of the so-called "***objective***" type (***multiple-choice, true-false, and matching***). Although these test items are objective in scoring, they are very subjective in writing. By varying the "***distractors***" in the test items, professional test item writers can get about any desired percentage of students to answer the question right or wrong. The trained researcher can do the same.

Number Of Test Items Do Not Necessarily Equal The Number Of Learning Objectives - In traditional education, it is the norm NOT to have specified unit and course learning objectives. In a similar manner, most traditional research units are also not based on specific objectives. As a result, the test items are developed on the basis of implied objectives. Some test items are related to objectives on a one-to-one basis (***such as rote memory objectives***) and others can have multiple test items related to a single objective (***such as process objectives***). Since few, if any, tests in research indicate which test items are related to which objective, the resulting scores don't reveal anything about what was actually learned by the students in the research.

For example: What if a research test is testing five objectives. Two of the objectives are rote memory items so there is only one test item for each objective. The other three objectives are process objectives and are tested by three items, five items and ten items respectively. The total test is a 20 item test. Five students taking the test could get the same score of 15. In traditional research, all scores of 15 are treated the same. However, by using various combinations of the test items related to the objectives, the five students could have "***learned***" two, three, four or five of the objectives and yet all have the same score of 15.

3.2 Contaminating The Research - Experimental vs. Control

Traditional researchers always want to have a control group to verify whether or not the experimental group really learned significantly more by the experimental method. However, many researchers contaminate the research by trying to make the control group match the experimental group.

For example:

3.2.1 They May Want To Use the Same Objectives

In most research involving programmed instruction, computer-assisted instruction or any systems designed instruction involving technology in which the experimental method involves the teacher or materials which have objectives specified, many researchers end up giving the same list of objectives to the more traditional control group. The problem is that the control group is no longer representative of traditional education in which teachers do not teach from specified objectives. The results are contaminated!

3.2.2 They May Want To Have Content Alignment

Many researchers, when trying to set up a control group to be tested against some specially developed materials to be presented via some form of technology, will use a print out of the designed unit for the teacher in the control group to use or maybe even for the students to use. The control group is no longer representative of traditional education in which teachers do not teach from specially designed curriculum units. The results are contaminated!

3.2.4 There May Be an Invalid Use Of Standardized Tests

In some research, the researcher wants to use a standardized test to give to both the control and the experimental groups. If the experimental group is using a specially designed unit and the control group is using the traditional unit and neither one specifically "*teaching to the standardized test*", the results are more affected by the correlation between the coverage in the standardized test and the coverage in the experimental and control groups than by the actual scores of the students on the test.

For example:

- If the experimental unit just happened to have a greater correlation with the standardized test than the content presented to the control group, the experimental group would get higher scores.
- If the content presented to the control group just happened to have a greater correlation with the standardized test than the experimental unit, the control group would get higher scores.
- In either of these situations, nothing is known about what was actually learned by the experimental or control groups because neither was specifically designed to fit the standardized test.

Special Note - Standardized tests are not usually based on specific learning objectives and especially not on objectives which are common to all schools using the tests. Because in the development of the standardized test, most of the potential test items which most students know are deleted, the test magnifies the differences in achievement. As such, a 10 percent increase or decrease in test scores could actually represent less than a one percent increase or decrease. In addition, another major problem is that the results are already designed into the tests. For example, whereas most standardized tests are pre-designed to give a "*normal*" curve of results, the NAEP tests are designed to give a three hump curve representing a cluster of items that most students know, a cluster of items that fit the "*normal*" curve and a third cluster of items few students can answer. So when the NAEP reports that only 17 percent of 13 year olds can answer a certain item, what does that mean?

- If it was designed to be a 12 percent item, than the learning is as expected.
- If it was designed to be a 50 percent item, than there is a problem in the learning event.
- If it was designed to be a 85 percent item, than there is either something very bad in the learning environment or the testing company needs to get a new test item writer.

3.3 Minimal Transfer of Research Results

In addition to the problems just covered, there is a minimal transfer of even successful technology research because of a lack of commonality of unit and course objectives among the nation's teachers and the resistance of traditional teachers to being replaced by some form of technology.

3.3.1 Lack of Commonality Is Caused By Academic Freedom

In keeping with the traditional concepts of "*academic freedom*", most teachers want to "*do their own thing*" in their classroom. They want the freedom to cover what they want to and to emphasize what they want to. As such, specially designed curriculum units to be used with technology will probably not match any teachers objectives (*if they have any*) and at best may have only an average correlation with the traditional teacher's objectives. The mis-match will sooner or later motivate the teacher to drop the technology and go back to his/her own presentations.

3.3.2 Resistance to the Presentations of Others Is Caused By Academic Freedom -

Because the traditional role of the teacher is as a "*presenter of course content*", most teachers will resist the use of any form of technology which is designed to take over the traditional teacher's presenting role. Even when a teacher develops their own media presentations, after a few semesters they will want to change it or just stop using it because it is replacing their role in their classrooms.

4.0 Instructional Excellence Research

When student learning starts to become the REAL emphasis in our schools and teachers begin to accept their real Professional role as that of helping all students achieve success (*at least 90 percent or more learning 100 percent*), then traditional educational research should be changed to research in Instructional Excellence in order to help the teachers and the students achieve their goals.

4.1 Maximum Transfer Of Research Results

One of the major problems in trying to use traditional research is that there is little commonality between the curriculum units researchers are using and what teachers are using. In order to have maximum transfer from the Instructional Excellence research results to the teachers in the classrooms, it is necessary to identify the maximum common core objectives.

4.1.1 Maximum Common Core Curriculum (*National, State, District, etc.*)

Over the years, any mention of a common core curriculum has been strongly resisted as interference with the teachers' and local districts' freedom. However it doesn't have to be that way. The process of identifying the maximum common core objectives involves identifying the national common core, identifying the additional regional/state common core and identifying the additional local district/college and university common core objectives. Added to that, teachers and students can add their own objectives to be learned above and beyond the combined common core objectives.

4.2 Instructional Excellence Research Concerns Student Learning Problems Through "*Worst Case*" Analysis

Instead of researchers selecting their best curriculum units to do research on as in traditional educational research, under Instructional Excellence research and common core curriculum, the researchers look for the "*worst*" curriculum units experienced by the most teachers This approach maximizes student learning gains and the transfer to the most teachers.

In closing, remember that the only reason for the existence of educational or instructional research should be to help the teachers help more students to become successful learners.

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EFFECTS OF LOGO INSTRUCTION ON SELECTED ACHIEVEMENT AND HIGHER ORDER THINKING SKILLS

Mary Ann Robinson-Gillis* and George E. Uhlig*

ABSTRACT

During 1986-87 and 1987-88 the authors examined the effects of Guided Discovery LOGO instruction on first grade students enrolled at E. R. Dickson Elementary School in the Mobile (Alabama) County Public School System. The treatment variable both years was comprised of one hour per day of pre-keyboarding, keyboarding, and Guided Discovery LOGO instruction in a laboratory setting. Dependent variables included selected subtests of the Stanford Achievement Test, the Peabody Mathematics Readiness Test, the Beery Visual Motor Integration Test, the Test of Cognitive Abilities, and student attendance. In preparing for this experiment the authors reviewed a number of related studies including twenty dissertations completed in 1985 and 1986 which focused specifically on the use of LOGO in the elementary school classroom.

These studies indicate that Guided Discovery LOGO has a statistically significant positive effect on higher order thinking skills, listening skills, selected mathematical skills as measured by the SAT, and on student attendance.

INTRODUCTION

During the 1986 - 87 academic year the authors initiated a series of studies on the effects of Guided Discovery LOGO on first grade students. The results of these investigations have been reported elsewhere (Gilley, Robinson, & Uhlig; Robinson, Feldman, & Uhlig; Robinson & Uhlig; Robinson, Uhlig, & Gilley; Robinson, Gilley, & Uhlig). The studies supported the belief that Guided Discovery LOGO can have a positive impact on selected aspects of achievement and higher order thinking skills of first grade students. The operational definition of achievement were the Stanford Achievement Tests; the Peabody Mathematics Readiness Test and Beery Visual Motor Integration Test were used to assess higher order thinking skills. Two factors related to these results were of concern to us. First, the significant positive impact on achievement tended to be unsupported by other research efforts. In fact, there are findings which will be discussed below which relate directly to this concern. Second, post hoc analysis of the PMRT and the VMI raised questions about the reliability and validity of the instrument. Consequently, a partial replication was carried out during the 1987 - 88 academic year.

REVIEW OF THE LITERATURE

"Higher order thinking skills can be simply expressed as those that students use to analyze and synthesize information. For example, planning the sequence of steps needed to solve a problem — the kind of reasoning exercised in programming — can be thought of as a higher order thinking skill. Other higher order thinking skills include synthesizing, and inferring." (Pogrow, 1985) Seymour Papert (1975, 1980) has suggested that experience with LOGO or other procedural computer languages may modify the ways in which other learning takes place.

In a controlled research effort with preschool children, it was found that children receiving a short-term LOGO experience had a significantly higher proportion of correct responses on two problem-solving tasks than children in the control group ($p < .05$). The authors also note that "In addition to the cognitive gains observed, the LOGO experience was certainly an enjoyable one for the children. It was clear from observing the enthusiasm and success with which children

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interacted with the computer that children of this age are certainly able to benefit from this type of computer experience. (Degelman, et. al., 1986)

An important study in this regard was reported by Rieber (1987). The experiment focused on 25 second grade children from a public school classroom. The experimental treatment consisted of three months of "guided discovery LOGO" An intact second grade class in the same school served as a control group. The experimental group receiving the LOGO experience performed significantly better on both the problem solving and geometry measures than the control group which received no such LOGO programming experience. The author makes an important distinction between this and other previous studies.

"One difference between previous studies and the one presented here . . . concerns the learning environment in which the LOGO programming took place. This study presented LOGO in a "guided discovery" environment where, although the teacher played an important role in the learning paths taken by the students, there was still an enormous amount of freedom for the students to experiment with the LOGO microworlds....Other recent research directly manipulating the LOGO learning environment has shown that 'free-discovery' is usually less effective than more structured approaches (cf. Kinzer, Littlefield, Delclos, and Bransford, 1985).

Our experience with first graders during the 1986 - 1987 year reinforced our belief that Guided Discovery LOGO was preferable to structured or discovery approaches, particularly when the amount of actual keyboarding time is limited.

OUTLINE OF STUDY AND METHODS

Both studies utilized two group quasi-experimental research designs. In both cases, the experimental group consisted of all first grade students in an intact classroom in a local public elementary school. The control group was comprised of all other intact classes in the same school.

The experimental treatment consisted of one hour per day of Guided Discovery LOGO instruction and selected pre-LOGO and pre-keyboarding activities. Instruction for the experimental group was provided by an experienced LOGO-using first grade teacher.

The dependent variables in the first study included the first grade subtests of the Stanford Achievement Test (SAT), the School Ability Index (SAI), the Peabody Mathematics Readiness Tests (PMRT), the Beery Visual Motor Integration Test (VMI) and school attendance. In the second study the Primary Battery of the Cognitive Abilities Test replaced the PMRT and VMI, and attendance was not included. The Stanford Achievement Test is used on a state-wide basis and was administered as scheduled following approximately 18 weeks of Guided Discovery LOGO activity. The Cognitive Abilities Test was chosen specifically for this study in order to assess this aspect of higher order thinking skills and was administered after approximately 24 weeks of Guided Discovery LOGO instruction.

The Primary Battery of the Cognitive Abilities Test is a single-scored untimed nonreading group of general cognitive skills and contains items that range from very easy to very hard. This battery is divided into four subjects: Relational Concepts, Object Classification (Multimental), Quantitative Concepts, and Oral Vocabulary. The battery was designed by the authors to include "...tasks that (1) are based on content that children of this age are likely to have experienced; (2) require children to use familiar material in a new way; (3) yield reliable assessments of cognitive development for children at different stages of development; (4) emphasize cognitive skills related to learning school tasks that children in Grades K through 3 are expected to master; and (5) are of interest to children of various backgrounds." (p 7)

The Primary Battery is a power test given without time limit. Internal consistency is reported at .923 for the Kindergarten Level and .894 at the first grade level. (p 24) The issue of validity — does the test really measure what it purports to measure — is of particular concern when dealing with young children and cognitive abilities or higher order thinking skills. The authors present correlations of the CAT to the Iowa Test of Basic Skills for grades 3 through 8. At the 3rd grade level (the lowest grade reported) correlations range from .76 (for mathematics) to .80 (for vocabulary and reading) and .87 (for the ITBS Composite score.)

RESULTS

Cognitive Abilities

In the initial study, significant results favoring the LOGO group over the control group were found on both the PMRT and VMI measures. Our concern over the reliability and validity of these two measures led us to attempt to find a better assessment measure of higher order thinking skills. As a result, we selected the Primary Battery of the Cognitive Abilities Test for the second study.

The Primary Battery of the Cognitive Abilities Test is comprised of four subtests and a total score. The subtests are Relational Concepts, Multimental Concepts, Quantitative Concepts, and Oral Vocabulary. The Guided Discovery LOGO group scored significantly higher than the control group on two subtests and on the total score. In all cases the experimental group evidenced higher mean scores than the control group. On Relational Concepts ($p = .05$) and on Oral Vocabulary ($p = .01$) these differences were significant.

Achievement

The Stanford Achievement Test at the first grade level is comprised of nine subtests and the School Ability Index (SAI). In the initial study, the LOGO group was found to have significantly higher scores on Vocabulary ($p = .04$), Listening Comprehension ($p = .045$), and Computation and Application $p = .014$). No significant differences favored the control group.

In the second study mean scores for the experimental group were higher than the control group on 6 of the 9 subtests and on the SAI. Two of these were significant: Listening Comprehension ($p = .05$) and Concept of Numbers ($p = .04$).

Attendance

Attendance was analyzed for the first year study. The experimental LOGO group evidenced significantly better attendance than the control group.

DISCUSSION

There are two important limitations to generalizing from either of these studies. These can be described as "teacher effects" and lack of random assignment of students to groups. In the latter case, given the nature of field-based studies in public school, we did our best to insure that students were assigned to first grades on a "non-systematic" basis. We observed no evidence either year that the principal assigned students to this class in any manner that would suggest that these were a more or less gifted group of students. Male-female, black-white, and repeater-non repeater ratios were not significantly different for the experimental group than for the any of the four classes which comprised the control group.

Teacher effects are harder to dispel. The first grade teacher who was instrumental in conceptualizing, designing, and conducting the Guided Discovery LOGO activities for the experimental classes exhibited an energy and interest level rarely encountered in the schools. It may well be that her students would perform better than others under any conditions. Would another teacher — with less interest in computers and LOGO — given the same conditions — experience the same results? We do not know, but there is some evidence we have inferred about Guided Discovery LOGO that may be generalizable independent of the "teacher effects" issue.

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IMPROVING THE BIDIRECTIONAL FLOW OF INFORMATION BETWEEN NEW JERSEY'S STATE EDUCATION DEPARTMENT AND THE LOCAL SCHOOLS

C. Ritschl [1]

ABSTRACT

This research paper is an analysis of New Jersey's State Education Department's collection of data from local educational agencies. The focus is on local policies and procedural issues and how this focus relates to the burden and the cost in managing school information. Managing information is generally perceived as important at the local and state level. Investigating local school data shows that little, if any, policies are written for data collection that assures compliance with state required annual reports. Furthermore, there is little evidence, that the data generated for the state has any practical utility for the school that prepares this data. A review of the state's data collection policies and procedures and a review of the literature provide for recommendations and a strategy for improving the bidirectional flow of information between the state and the local schools.

THE PROBLEM

New Jersey's local educational agencies (LEAs) do not have a coherent and efficient data processing approach in meeting state and federally mandated or regulated reports. The state's adopted "thorough and efficient" educational legislation implies that such procedures may indeed be in place, but in actuality the state's data collection and reporting system is ill-conceived, and not targeted to solve local problems or fulfill local or state specific objectives.

The state's data collection is poorly aligned with the needs of the LEAs, and it lacks any evidence that the reporting efforts are in the best interest of students, teachers, administrators, school boards, and the public. More precisely, it is costly in terms of money, staff spending time on off-tasks, and on staff morale.

The SED asks for information that may never be used or may not report back what could be useful to the LEA. Therefore, information is not bidirectional. The various departments request similar information, therby making many reports redundant. The SED leaves it up to the LEA to track down what is locally useful. To receive meaningful data, the an understanding of the maze of the various departments and knowing the right contact persons is necessary.

The above problems raise questions about the state's and the LEA's data. This paper explores the following questions:

a. Who are responsible for what school related information?
b. Who are the important (SED, LEA, others) users of this data?
c. What role do the state's legislature, the SED, and the LEAs have in storing, reporting and improving information?
d. What is the paper work cost for collecting, processing, reporting and storing this information?
e. Which data elements are absolutely necessary and cost-effective from the SED reports and which can be done away with?
f. How do the LEAs and the SED prepare and use the data?
g. How does this data relate to positive student academic outcomes or show improved social (staff or community) outcomes?
h. What are the social and legal ethics in having or sharing the information among partisan and nonpartisan users?
i. Can current and future technologies help improve the bidirectional data flow?

The SED places greater emphasis on the completion of the final required reports on specific due dates rather than on ***how or why*** they are completed at all. The major problem is how to have schools provide required state reports in an efficient and cost effective method.

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There is a need for a system that does not burden additional local resources and that can make beneficial use of the locally prepared data.

INTRODUCTION

Using management science tools, this paper focuses on local school level policy and procedural issues associated with data. How these issues relate to the human resources and the related monetary cost are also compared. Review of several LEAs' policy manuals show how little, if any policy or procedural information exists in the above area. Contact with the New Jersey School Board Association's (N.J.S.B.A.) policy services did not provide additional knowledge on policies for the management of information relating to student, personnel or financial data.

Based on N.J.S.B.A. data, only five schools of the 592 operating districts in the state of New Jersey had a statement on data processing in their policy manuals! There doesn't appear to be current legal or worthwhile concerns for districts to start such policies. It appears that schools are not writing policy for their data processing needs unless the SED requires it. Even though written LEA policy is not what this report is investigating, it does suggest a school's indifference in this area. It may be said that some schools do not want to know the information that can be made available to them. Some other schools may not have the expertise in this area.

Information is a double edged sword. There is "good and bad" information that can reflect the district in a positive or negative light. Ignorance of information can be bliss for some poor achieving districts.

This minimal data provides a scant and dismal quantitative analysis on the topic of local school district management of information. From those few districts who had policy statements, the policies were general and rather vague.

> The superintendent and board secretary/school business administrator shall continually study and recommend to the board the most ***efficient, economical, and secure*** (emphasis added) means of entering, storing, retrieving, and using data concerning the pupils, personnel, and operations of the district.
>
> Legal Reference: **N.J. Administrative Code**. 6:3-2.4(c) Maintenance and security of pupil records.

Asking the same five schools if there were written regulations and procedures in place for determining "**efficient**" use of school information, or for analyzing the "**economic**" savings from their data processing efforts, or for carrying out methods in "**securing**" their data turned up minimal answers. The only response was adherence to the maintenance and security of pupil and personnel records. The lack of legal mandates discourages requiring the other attributes.

From the meager data available, it was evident that further inquiry in this untouched area is required beyond the local school level. Therefore, contact with twenty New Jersey schools and the New Jersey State Department of Education (DEC) at the county and state level provided additional information. Only one of the twenty schools contacted suggested that they had a similar policy statement as above and not much more. These same districts voiced their concern from the increasing data demands by both local and state level management.

THE STATE EDUCATION DEPARTMENT

Telephone and personal interviews with state officials see the paper burden and the relevance for the LEA for preparing the state level data as being a critical component for LEAs' acceptance of their tasks. The virtues of a system of information management is said to be its usefulness in relating ends to means in a comprehensive manner. This same sentiment was echoed by the chief state officials, because "there is a major need for LEAs to buy into the state's data collection process through someone at the state level being able to demonstrate the utility at the local level." From past practice, there is no evidence that someone from SED has done this convincingly. LEAs see the data collection process as necessary state-required tasks with little if any local merit.

The SED appears to have the most comprehensive policy and procedures in the state for the collection of school data. The purpose of the SED data collection policy is:

> To minimize the paperwork burden on local education agencies and effectively monitor data collection activities, ... and to provide a systematic procedure to gather accurate, reliable, timely, and useful information from a specifically identified responding source."

In the Spring of 1988, the SED conducted a survey of sixty school superintendents on the SED-LEA concern for the flow of information. This SED survey has not been made available at the time of this report. Considering that the majority of SED reports have to do with financial, personnel and pupil data, it may have been more indicative for the survey to have interviewed those who have more direct responsibility for creating those reports (i.e. business, personnel or pupil services administrators) rather than the superintendent of schools.

SURVEYS

Seventeen schools were surveyed by phone on computer technology, data collection, and on reports management. From these schools, 72% favor SED specifying a particular computer system on which to run SED developed and financed applications. An overwhelming 94% support electronic transfer of information and 100% report that the legislature should take the lead and fully support this ambitious undertaking.

An I.B.M. survey of their mid-range users showed that about 40% of the users surveyed by phone have custom programs for state reporting that they funded locally. Comparing the tri-state area (NY, NJ, & Conn.), each state has different data requests and how that data is handled. This is costly for the individual LEAs, who must bear the cost alone.

TESTING THE SED PAPERWORK REDUCTION HYPOTHESIS

Policy decisions must be made based increasingly upon demonstrated considerations of both costs and the effects of such decisions. Levin (1987) makes a strong point on the importance of using cost effectiveness analyses in evaluations that can lead to more efficient use of educational resources. This can best be seen by considering, as an example of both costs and its effects, the state's "Application for State School Aid" report.

The hypothetical example shows that the district's estimate of paperwork is higher than what the SED may show when requesting this report.

Table 1 shows the SED underestimated the LEA time by 90 hours (229% less) for completion of the report and overestimated the business administrator's time in the collection process by 20 hours (200% more). This misquided estimated workload appears to be shared by many at the local level. The labor costs can be derived from the average published school salaries. Figure 1 is a productivity study done for one school comparing the time and cost benefit for doing various office tasks manually versus doing tasks through automated means.

Title	Number of Individuals		Time/Indiv. hours.	
	LEA	SED	LEA	SED
Asst. Principal (HS)	2	1	60hrs	10 hrs
Asst. Principal (MS)	2	1	40hrs	10 "
Principal (Elem)	1	1	40hrs	10 "
Business Administrator	1	1	20hrs	40 "
TOTALS	6	4	160hrs	70 hrs

Table I. LEA and SED estimated comparisons on the amount of time persons require to complete data for State School Aid.

THE FLORIDA INFORMATION RESEARCH NETWORK (F.I.R.N.)

A review of the literature showed very little information in state-local school communication. Most articles were of the "show and tell" variety that provided authors an opportunity to blow their own bugle about their programs, and not much else. It appears that higher education has had more database networks with state government agencies and among other universities across the nation. There are examples of library networks (Angus, 1986), electronic mail between the state legislature and universities (Klein, 1984), school level testing information tied into the state's education department (Bigelow, 1986), state recommending a standard hardware and administrative software configuration to ensure statewide compatibility to reduce paperwork (Hill, 1987, South Carolina's Pathways Project), transmitting annual

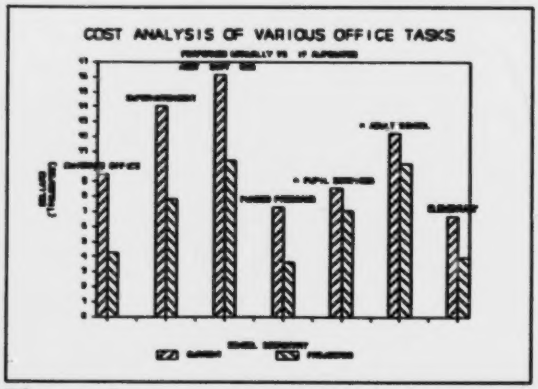

Figure 1. Cost benefit comparisons of manual vs. automated secretarial tasks.

attendance and enrollment reports from computer regional centers to the SED (New York's Technology Network Ties) and a comprehensive network connecting the state legislative agencies with the state university systems and the local public schools (Allen, 1983).

Florida's F.I.R.N. project has been in place since 1981 and it is the most comprehensive network for the flow of data between state agencies, the state universities, and the public schools. Florida uses IBM's proven SNA network and packet switching communication protocols to achieve hardware and data integrity among its users.

The State of Florida has long recognized the importance of decision making elements and has, over the years, continually worked to improve not only the skills but also the information base used to set the course for public education. In the latter of these efforts, improving the information base, computer technology has been viewed as a vital tool yet one often presenting as many problems as solutions. In essence, the purpose of developing a network is to - deliver the right information at the right time to the right place as efficiently as possible. The following figure 2 presents a communication network hieratchy for New Jersey:

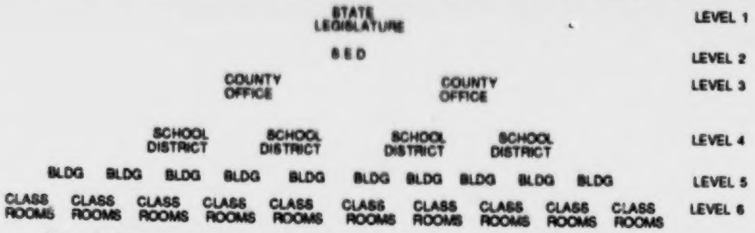

Figure 2. A governance structure for implementing New Jersey's state-local computer network.

As illustrated, there are six levels in the pyramid ranging in function from executive (setting policy and long-range plans) to management (allocating and overseeing resources to implement policies and plans) to operational (delivering resources to the target population). At each level a variety of information needs exists, all sharing common characteristics.

RECOMMENDATIONS

The F.I.R.N. Project is an exemplary comprehensive state model to emulate. It represents a unique accomplishment for public education in the United States. A governance structure for maximizing the representation and coordination of resources for New Jersey is highly recommended. David Brittain, Administrator of F.I.R.N., describes three areas of importance to ensure success for states involved in such a comprehensive system; (a) maximize the political/legislative arena, (b) plan and sell the economic/budgetary arena, and (c) use proven technology that optimizes the existing and future hardware.

There is a need to develop a multi-phased plan that builds upon existing facilities and capabilities. The plan should proceed through a logically paced sequence of events and acquisitions. The phases should be independent plateaus that can stand alone and offer a degree of enhancement for each following year. Activities for each phase of implementation should gradually build from a pilot program to the full networking of all public education entities within New Jersey.

Throughout the multi-phased plan, data should be maintained on costs-benefits, paperwork reduction, accuracy and timeliness, equity access and the sharing of resources, and the use of electronic mail. Evaluations done in these areas would determine the plan's continuation and the merit of the plan for other states.

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CHARACTERISTICS OF LEADING ELEMENTARY SCHOOL INSTRUCTIONAL COMPUTING PROGRAMS

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ABSTRACT

In late 1987, a study was conducted which examined aspects of high quality elementary school instructional computing programs. The results illustrate for instructional computing leaders the approaches adopted by the decision-makers in a national sample of elementary schools identified for the excellence of their instructional computing programs. Noteworthy budgetary findings include a dramatic decline in instructional computing expenditures compared with previous years; in the 1987 budgets, 73% of the funds were spent on hardware whereas only 15% were devoted to software purchase. In addition, the study found a major shift in the way that leaders intend to allocate their available computer time in the future. Cooperative planning was undertaken by committees comprised mainly of principals and classroom teachers. The most critical contributors to program development were mainly equipment-oriented; the most significant barriers to program development were more people-oriented. Apple IIes were overwhelmingly the computers of choice and word processing was rated the most valuable instructional computing use.

INTRODUCTION

During the 1987-88 academic year, a study was undertaken investigating characteristics of elementary school instructional computing programs selected for their high quality. The study identifies common characteristics of the excellent programs and provides guidance to instructional leaders which increases understanding of the processes used to develop and maintain successful elementary school instructional computing programs. The opinions of leaders whose programs are recognized for their high quality can be especially useful to other school administrators seeking advice on how best to use the limited resources available to their schools for instructional computing.

OUTLINE OF THE STUDY

A national search identified 73 elementary schools with high quality instructional computing programs. The Office of Technical Assessment (OTA) in Washington, D.C., supplied a list of districts known for their support of instructional technology. Representatives from these districts then identified the particular elementary schools within their areas which they believed had developed the most outstanding instructional computing programs. These schools were surveyed with a 70% response rate.

The survey instrument was designed to gather data on the following topics: various budgetary considerations, allocation of valuable computer time, school planning process characteristics, time periods for which schools have had instructional computing programs, the extent to staff involvement, and important barriers and contributors to instructional computer program improvement. The instrument additionally identified the type and location of the computers within the schools, the computer uses considered the

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most important in facilitating student learning, and the effects of program longevity on instructional computing practices.

FINDINGS

A dramatic drop in budgetary expenses was, perhaps, the study's most notable finding. The first declines detected were from the average expenditures for the years the programs were developed to the 1986 budgets. Further declines were noted from the 1986 budgets to the 1987 budget levels. The median for the average annual expenses (incurred while programs were being established) was $20.00; for 1986. the median was $8.80 for 1987, the median dipped to $4.90. Thus, after five years (on average) of nearly $20 per student annual expense to develop its program, the typical school expense dropped to less than $5 per student by 1987. These per student budgetary amounts are noticeably different from the figures supplied by either Moursund and Ricketts (ref 1) or Leven (ref 2).

The mean 1987 per student budgetary figure indicated that 73% was spent on hardware, 15$ on software, 9% on staff development and 3% on equipment maintenance. Therefore, the $4.90 per student was divided so that $3.57 was spent on hardware. $0.74 went to software, $0.44 was spent on staff development, and $0.15 on equipment maintenance. These findings also found that computer expenses are not permanent line items in the budgets of over 79% of the schools surveyed.

Another important finding involved the division of allocated computer access time. Tyler's (ref 3) three categories of educational computer usage were employed to stratify the available time. The available time was mainly allocated to computer-assisted learning (55%) and computer applications (29%), with less time (14%) given to computer programming in either Logo or B.A.S.I.C. or both. The three specific activities with the highest frequency of occurrence--drill and practice (24%), word processing (18%), and tutortials (12%)--accounted for more than half of the total computer access time. However, the study revealed a major shift in the respondents' ideal allocation of comptuer time. Nearly one half of the respondents would spend 50% or more of their computer time on computer applications, up from less than one quarter that actually spent that amount of time on computer applications. Overall, the ideal computer time allocations showed a lesser emphasis on computer-assisted learing and a correspondingly greater emphasis on computer applications.

Findings involving the type and location of the computers, the level of staff involvement in instructional computing, the characteristics of the schools' planning processes, and the instructional computer uses most highly regarded by school leaders also proved interesting. The computers, overwhelmingly Apple IIes (87%), were situated in both computer labs and individual classrooms in nearly seven out of eight schools. Planning generally involved shared decision-making processes using computer committees composed primarily of classroom teachers, computer enthusiasts, and building principals. The typical elementary teaching staff was highly involved--often 100%--in the instructional computing program. School leaders recognized word processing (55%) as their most highly valued method of using computers with students. Improving basic skills (27%), and keyboarding (16%) were other student uses often mentioned as valuable.

Other notable results include the factors which were identified as significant contributors or barriers to program development in the past ("3 years ago"), present ("now"), and future ("in 3 years"). Five factors were identified as the most important contributors to instructional computing program inprovement over the last six years. Adequate hardware was the most vital contributor in both the past and the present. Adequate software was the most consistently important contributor and, also, the most significant contributor in the future. The other three important contributores were administrative support, the willingness of teachers to change, and staff inservice programs. The most significant barriers in the past were inadequate staff training, lack of quality software, insufficient hardware, and lack of staff commitment. Teachers resisting change was the most significant barrier in the present and future as well as the most consistent impediment over all three time periods. Significantly, the factors considered the most important contributors to instructional computing program development were primarily equipment-oriented whereas the factors identified as most significant barriers to program development were primarily people-oriented.

Additionally, computing programs which had been established for some years differed substantially from more newly established programs in every characteristic examined--equipment availability, budgetary considerations, the number of years for which plans have been made, the extent of teaching staff involvement, and the actual and ideal allocation of computer access time. The more established programs have developed plans covering longer periods of time and typically have permanent budget line items to ensure the funds needed to implement the plans. The establilshed schools involve a greater number of teachers in their programs and provide a greater ratio of computers to both teachers and students. They also place far greater emphasis on computer applications than on computer programming or computer-assisted learning than those schools with relatively newer programs.

SUMMARY AND IMPLICATIONS

These findings have implications for educational leaders at the building, district, and state levels as well as for educational researchers. The findings offer guidelines to assist the decision-making processes of the nation's elementary schools presently developing their instructional computing programs. The different manner in which the more established schools allocate their computer time offers a strong message to educators who are uncertain about which computer modes to emphasize in their programs. The leaders should combine an awareness of the importance of computer applications with careful long-term planning. The plans must include increased opportunities for teacher training and for staff involvement in the planning processes used to determine future directions of the instructional computing programs.

The results also warrant more detailed investigations into the factors which might be influenced by an instructional computing program's relative maturity. The findings also raise questions concerning the respondents' projected computer time allocations. The new allocations, with a greater emphasis on computer applications, will require more hardware and teacher training than present utilization modes. For the projections to be actualized, spending on instructional computing must be increased. This necessity is one of several revealed by the study which are contrary to the practices reported by the respondents. These disparities have serious implications for the future success of instructional computing. Educational leaders and legislators must work tegether to provide the funding necessary to guarantee that the power of computers is available to all students.

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DEBRIEFING: AN ESSENTIAL ELEMENT IN MICROCOMPUTER USE

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ABSTRACT

Frequently teachers frustrate their students by assuming that learning automatically takes place during CAI utilization. Consequently, little time is allocated for follow-up activities. Beyond a short review of content, usually few opportunities are provided for the attainment of higher-level learning objectives. By constructing a plan for debriefing, teachers can relate new concepts to past learning and maximize the development of positive associations. Basic research supports debriefing as a major element in successful instructional programs. Researchers have proven the value of recalling, summarizing, and analyzing new knowledge.

INTRODUCTION

Using CAI software systematically in the curriculum involves several key elements; teacher preparation, student preparation, utilization strategies, monitoring activities, follow-up review, and evaluation plans represent major constructs related to effective utilization of educational software. Debriefing is the central element directly related to the enhancement of learning--a crucial part in CAI utilization. Raths in 1987 (ref 1) defined debriefing as the process that gives students free rein to organize, evaluate, summarize, or analyze a learning experience. Debriefing and integrating learning activities with a unit of instruction is often neglected by teachers. By expanding the follow-up sessions, teachers can provide meaningful learning experiences leading to the attainment of "personal knowledge".

By providing bridges from old knowledge to new learning, students can better analyze the new information in a manner that amplifies and clarifies both old and new constructs. According to Gray in 1988 (ref 2), some of the major outcomes of debriefing are:

* Increased understanding of content;

* Improved problem-solving strategies;

* Exposure of misunderstandings and personal theories;

* Added ability to recall content; and

* Increased motivation.

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The outcomes of a comprehensive debriefing session are the meaningful integration of content, increased motivation, and excitement for the next CAI experience.

DEBRIEFING STRATEGIES

Teachers can select from a large number of debriefing strategies that will enhance learning. Listed below are samples of techniques illustrating the concept of debriefing; talented teachers can certainly revise and expand on these examples.

Role-playing is an effective debriefing activity for enhancing decision making and serving as an emotional release for some engaging simulations. After the emotional release, students can more objectively analyze their decisions. The Oregon Trail (MECC) is a prime example of a simulation that can be followed by an exciting role-playing activity. One scene from the program could be used to role play which could include key decisions involving getting food, fording a river, and purchasing supplies.

Students can also write a reaction paper which can facilitate the summarizing and analyzing of the major concepts in an educational software program. Where in the World is Carmen Sandiego? (Broderbund) is an excellent example of a program that can be used with this debriefing strategy. By the use of maps, students could indicate key characteristics of the various countries visited by Carmen. This type of debriefing activity helps students to synthesize geographic facts into concepts.

Drawing a visual summary at the conclusion of a computer activity enhances newly acquired concepts by providing a concrete experience. By producing transparencies of the drawings, students could share their visuals which should improve class performance and, at the same time, increase motivation. After using Botanical Garden (Sunburst), students could draw a series of pictures depicting plant growth under a variety of conditions.

In 1988 Jones et al (ref 3) emphasized the importance of students using graphic representations to facilitate learning. They stated that "a good graphic representation can show at a glance the key parts of a whole and their relations, thereby allowing a holistic understanding that words alone cannot convey." Students can use charts, graphs, posters, or more specifically, a continuum scale, a problem-solving outline, a cycle chart, a network tree, or a compare/contrast matrix. Graphic organizers are basic to skilled thinking because they provide an avenue for analysis that is normally not provided by software design.

Comparing and contrasting concepts provides a bridge between old and new knowledge. By using a chart, students can tabulate their reactions in an organized manner. This activity can be done effectively as a large group discussion. Many software programs can be used in this manner, including the Oregon Trail and Where in the World is Carmen Sandiego.

Evaluating the program using standard evaluative criteria can assist students in understanding content and, in addition, provide the teacher with valuable feedback regarding the software program. By having students check the objectives of the CAI program, they can also assess the adequacy of the learning experience. This experience has an added plus: it can produce more critical consumers of computer software.

THE ROLE OF THE TEACHER

It is important that teachers plan the debriefing activity carefully. All resources and equipment ought to be organized and readily available for student use. For certain activities, additional library resources may be needed.

Feedback from other faculty and students should be encouraged. A collaborative model in designing debriefing activities with student input may provide an added catalyst to learning.

During the debriefing sessions, it may be necessary to teach learning-to-learn skills. Researchers in educational psychology have identified three major skills to facilitate the process of learning: attention training, cognitive restructioning, and self-evaluation. In addition, research has found that when students used self-monitoring the degree of involvement and overall academic productivity increased significantly.

CONCLUSION

The debriefing activity can represent the most important stage of CAI utilization. It provides the teacher with an opportunity to magnify, expand, and make more permanent the learning from educational software. In addition, the debriefing experience can be an exciting--very motivating--learning activity for students. It is a chance to promote critical thinking skills with CAI use. This is a major opportunity that teachers cannot afford to miss.

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A SURVEY OF READING AND LANGUAGE ARTS SOFTWARE USED IN FLORIDA: RESULTS AND EDUCATIONAL IMPLICATIONS

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ABSTRACT

This research project funded by Florida State University was designed to ascertain the use of computer software and hardware in reading and language arts programs in elementary schools in Florida. A survey was developed and sent to public and private schools throughout the sixty-seven counties of Florida. The survey results indicate: (1) the Apple computer is the predominant computer used in Florida schools (2) budgets for computer software remain small and not a budget line item (3) classroom teachers and aides have the primary responsibility for computer instruction (4) the majority of the software used in non-basal specific and usually single disk (5) inservice training for computer literacy and evaluation of software is very limited and (6) students spend an average of 30 minutes per week on a computer.

INTRODUCTION

The integration of computers into the academic curriculum has been heralded by educators, computer vendors and legislators as the direction to go in seeking innovative instructional strategies. This technology has the potential for meeting the academic needs of the gifted as well as the at-risk students. However, it appears that neither the school personnel nor the students were prepared to take advantage of this unique opportunity to assimilate this technology into the school curriculum.

Recently, there has been a phethora of computer surveys at the national and state levels. In Florida, an initiative to assess the role of computers in public schools was undertaken by The Division of Public Schools of the Department of Education. Since the Florida legislature had recently appropriated $630,000.00 to acquire software programs at the lowest price possible, a survey was developed and sent to all school districts requesting a list of top subject area priorities when purchasing computer software. There were five priority areas listed for software titles within the categories of elementary, middle and high school levels. The results of the survey indicated the highest demand at the elementary level with language arts designated as the priority content area.

Based on these survey results, the Department of Education wrote a Request For Proposals (RFP) and seventeen companies responded. This process resulted in a word processing program appropriate for grades K-8 being selected for statewide adoption and distribution. School districts will receive copies of this program and inservice training based on the student population ratio in the elementary and middle

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grades. This process for selecting new software for statewide adoption will continue each year.

FLORIDA SURVEY: DATA COLLECTION AND ANALYSIS

To determine the status of computer usage in Florida schools, we developed a survey which was sent to selected public and private elementary schools. We were interested in determining the extent to which computers have impacted the reading and language arts curriculum at the elementary level in the State of Florida. The purpose of this research project was three fold: (1) to determine how many schools have incorporated microcomputer software into their reading and language arts programs (2) to ascertain where the computer instruction is occurring i.e. classrooms, media centers or computer labs and who is providing this type of instruction and (3) to gain information regarding the selection and evaluation process used by schools when purchasing reading and language arts software. Thus, this project was designed to broaden and expand the knowledge of what is currently happening in the State of Florida regarding computer use in the content areas of Reading and Language Arts at the elementary level. A letter and survey were mailed to three hundred and thirty-three (333) schools. An overall response rate of fifty-two percent (52%) was achieved. Public school survey responses totaled seventy-nine percent (79%) while the private school responses totaled thirty-six percent (36%). Urban, suburban and rural areas were included in the responses received and schools in forty-six of the sixty-seven school districts responded to the survey. School administrators, teachers, computer and media specialists were targeted as respondents to the survey.

There were six major objectives identified for this research project: (1) to determine who was providing computer instruction for reading and the training and background of these individuals (2) to determine where computer instruction was occurring - classroom, media center or computer lab (3) to determine the software being used in reading and language arts programs (4) to determine what kind of computers were being used for instructional purposes in reading and language arts programs (5) to determine the funding being allocated for computer hardware, computer software and computer inservice training and (6) to determine the software evaluation and hardware selection process used by schools and/or school districts. Therefore, the survey was divided into six categories: (1) school data (2) personnel data (3) computer data (4) software data (5) selection and evaluation data and (6) inservice training data. Survey results were analyzed using these six major categories which reflected the objectives of this research project.

SURVEY RESULTS

I. School Data - Two hundred public schools and one hundred and thirty-three private schools received surveys. Public school survey responses totaled seventy-nine percent (79%) while private school responses totaled thirty-six percent (36%). Responses were received from urban, suburban and rural counties.

II. **Personnel Data** - Principals, assistant principals, computer specialists, classroom teachers and media specialists completed the survey. Their average on-the-job experience was fifteen years.

III. **Computer-Data** - Of the forty-six school districts responding, Apple was the predominant computer (51% public, 59% private.) IBM was second (27% public and 18% private) and Tandy/Radio Shack came in third (11% public and 24% private). Most school districts reported no budget line item for computer hardware and software. The budget range was $500.00 to $1500.00 for those public schools with a computer budget. The private school range was higher; $500.00 - $9000.00. However, public school district budgets were enhanced with federal and state dollars. Computers in the schools average twenty-five to thirty-five per school. Most computers are housed in either a computer lab or a classroom setting. If they are housed in the media center it is usually in an adjacent room. Chapter I programs usually have separate computer labs with separate curriculum software guidelines for approved appropriate materials. Students in special programs often receive as much as one hour per week of instruction while students not in special programs usually receive only thirty minutes of instruction per week.

According to our survey, classroom teachers are the primary providers of computer instruction in the schools (44% public, 15% private) with teacher aides ranking second (30% public only). In private schools computer specialists rank first as providers of computer instruction (public 10%, private 73%) with media specialists ranking second (public 16%, private 20%).

IV. **Software Data** - Approximately eighty percent (80%) of the reading and language arts software used in Florida elementary schools is non-basal reader specific. Approximately two (2%) of the schools surveyed are purchasing only single disk/single skills programs.

V. **Selection and Evaluation Data** - Media specialists, classroom teachers, curriculum specialists, computer specialists, reading specialists and special program facilitators are the personnel responsible for software purchases and software evaluation procedures. Students, aides and subject area committees are frequently involved in the evaluation process. Some purchases are made through statewide buy programs or by licensing agreements such as MECC programs.

VI. **Inservice Training Data** - In Florida, consultants working for Teacher Education Centers (TEC), curriculum specialists, hardware and software vendors as well as other educational consultants provide training in computer instruction. Seven public and three private schools responding to the survey require at least 10 hours of inservice training. According to the survey results, teachers often attend summer computer institutes held at a nearby university.

EDUCATIONAL IMPLICATIONS

In order for computers to be incorporated into educational programs, the personnel involved must be trained to implement this technology. Inservice training is a must. While many states have allocated funds for computer hardware and software purchases, only limited funds have been allocated to train teaching personnel how to efficiently use computers as an integrated part of the academic curriculum.

Our study showed that a small percentage of schools do require at least 10 hours of inservice training but many school districts did not require inservice training or university courses. It is highly recommended that all school curriculum personnel and classroom teachers have at least 10 hours of inservice training and/or a three hour university course. This training should include the operation of a computer, review and evaluation of software in major subject areas and most of all how to incorporate this software into daily lesson plans.

The selection and evaluation of hardware and software should be accomplished through an evaluation team. This team should consist of classroom teachers, school administrators, subject area curriculum specialists and preferably a student "tryout" class. Each school system should create a standard evaluation form for hardware and software. Such forms provide continuity throughout a system even when personnel change.

More time should be spent on computer instruction. The current average of 30 minutes per week at the elementary level is far from adequate. Additional time is needed for students to enhance their writing skills using a word processor as well as improving their reading skills through computer assisted instruction. The reading and writing connection helps provide continuity throughout reading and language arts programs.

SUMMARY

This study surveyed public and private elementary schools in Florida to determine what computer hardware and software are currently being used in reading and language arts programs. The Apple Computer continues to be the predominant computer used in schools both nationally and in Florida. Budgets continue to be varied and often not a line item. It is the classroom teachers and aides who are providing most of the computer instruction with very little inservice training required. Finally, in the areas of Reading and Language Arts most of the software is non-basal specific and often is single disk/single skill specific. Certainly, education has a long way to go before it can reap the full benefits of this technology.

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GORILLA COMPUTING

K Harris

ABSTRACT

You've heard the old joke. Where does a gorilla sleep? Answer: Anywhere he wants to. That's what Gorilla computing is all about. What should students do with computers? Answer: Anything they want to. Work with children who are motivated by their interest in computers, and you will find that gorilla computing can be an effective way to involve them with computers. It just seems healthy to nurture whatever interests children may have in computers, and for certain children, this merely means that we give them access to a computer and stand back. However, I do not mean to suggest that this requires no teacher planning and preparation. In my experience, no matter how gifted or motivated a young person may be, they need guidance and direction, at the very least, and often a certain amount of instruction as they tackle computer programming or one of the many computer applications in their effort to navigate within the compu-jungle. As a fifth grade teacher, having faced all sorts of bureaucratic constraints, I have learned a few tricks which have allowed my students computer experiences that they would otherwise have been denied due to tight scheduling of computer labs or limited access to computers. Therefore, in this paper, I intend to discuss how teachers in typical public schools can prepare and implement this kind of free-wheeling computer experience for their students.

I will discuss:

1. Experience disks - These are disks that contain numerous BASIC programs that I have selected as appropriate for that particular group. They might contain programs that emphasize a certain curriculum subject area, or they might be a hodgepodge of programs which children might enjoy exploring.

2. Access to appropriate BASIC programs.

3. To what degree we should make these "experience disks" self-loading.

4. The use of self-paced lessons to teach children how to program in BASIC or Logo.

5. How learning to program changes the entire student/computer relationship.

6. The use of student generated data bases.

TEACHING PASCAL AS A PROCEDURAL LANGUAGE

Richard Earp*

ABSTRACT

Pascal is a language that is structured and well typed; it is a language that is well suited as a basis for learning the semantics of procedural computer languages. It is necessary to introduce some algebraic background for the students to understand the concept of variables. For teaching the procedural constructs of sequence, condition and iteration, examples and problems should be well chosen to emphasize good programming practice. The principles of software engineering must be adhered to when teaching procedures. The goal of teaching Pascal is to define good programming as maintainable programming using the ideas software engineering.

INITIAL ASSUMPTIONS AND EARLY TEACHING

The problem of teaching a computer language begins with the assumptions made about the students. Unlike some years ago, today's students are quite well prepared to handle many of the problems of basic computer literacy that held back earlier teachers. Typical students have used packages on computers and have familiarity with keyboards, floppy disks and monitors. Most students have also used an electronic calculator. Using all of these experiences as a base, the foundations of teaching computer/human communication are enhanced. The apprehension about learning to use a computer has been replaced with a healthy curiosity about how programmers have written the packages that are used. Instead of concerning themselves with literacy, modern teachers must reassemble the knowledge already gained into a mentality that promotes good programming practice.

Before beginning with teaching Pascal syntax itself, there are two major areas that must be addressed: algebraic notation and procedural language orientation. Before the teacher can enter the world of Pascal syntax and computer use, the student must understand the concept of handling variables. Students that have had algebra will have little problem with the concept of a variable; however, students who have not been trained in algebraic notation will first have to be introduced to it. The idea of pseudo-programming without regard to syntax will promote the idea of procedural language semantics. While the syntax of Pascal is certainly important to a knowledge of the language, the semantic concepts of programming are far more universal. Early concepts should include: variables, sequential execution of instructions, input and output, and unambiguous arithmetic. The terms "semantics" and "syntax" should not be confused by

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students. It is too easy for beginning students to feel very comfortable with language syntax, but not be able to compute anything.

Another early thought is to recognize that the landscape of computer languages is broad. Pascal is primarily a member of the family of procedural computer languages. Many students will have heard of other languages and may have experimented with some of them (e.g., BASIC). To teach Pascal requires that the instructor have an idea of the spectrum of computer languages and the place of Pascal in the spectrum. A very brief background and history of computer languages in general is appropriate to the subject of teaching Pascal. Procedural languages (FORTRAN, COBOL, BASIC, PL/1, etc.) are contrasted to the object-oriented languages (LISP, PROLOG, LOGO, etc. in form and use. The Pascal overlap into object-oriente language should be discussed. Some simple, object-oriented examples should be given to show that process of thinking. This object-oriented approach should be contrasted with the procedural, sequential programming used in Pascal or BASIC. A very common trap of students and some teachers is to preach the advantage of one language at the expense of all others (the "my favorite language" trap). Students should recognize that all computer languages were developed for some use and gained some acceptance. Some languages are poor by software engineering standards, but are so widespread that they cannot be discounted as "useless," "out-of-date," or "unworthy of study."

BEGINNING PASCAL

To begin the study of Pascal syntax, a simple, sequential program should be presented and programmed. A program like "find the mean of three numbers" is appropriate. This first program will superficially demonstrate what a program looks like, but beyond the surface will be the important lessons on typing, naming variables, indentation and comments. To write a program in Pascal it will be necessary to introduce the idea of either INTEGER or REAL variables. At this early stage, both types of variables should be mentioned with the caveat that the types are never mixed. The enforcement of strong typing will come later, but this important idea must be conveyed early.

The syntactical operators and operands and general program structure will be evident. A major point to be made here is there are many ways to write a program to correctly "find the mean of three numbers"; however, just because the program gives the right answer does not make it a "good" program. A "good" program is one that can be maintained. Students must be shown that this first program not only works but also can be changed by anyone literate in Pascal. Variable names must be meaningful. Programs should always be dated and have the author noted. Indentation should be introduced as a standard. Pascal rules for syntax must be taught, but not overdone. If language rules are stressed, students will learn how to write proper statements, but may never learn how to write good programs. To write programs requires going beyond syntax rules to introduce standards that will be adhered to in all programs (e.g., naming conventions, indentation and comment-documentation).

BEYOND THE FIRST PROGRAM

After having introduced the student to syntax and good programming convention, more substantial programs must be advanced. The first study beyond the initial program usually involves arithmetic. After normal operators are introduced, the problem of ambiguity must be addressed. Ambiguous arithmetic expressions are not to be tolerated. The use of parentheses in all ambiguous expressions should be taught.

Procedural languages are based on the components of sequence, condition and iteration. Principles of software engineering (abstraction, information hiding, cohesion and coupling) should be introduced early in the process of learning programming so that they can not be overlooked or bypassed. To see the principles most clearly, one needs procedures; however, to see how procedures work, some background on condition and iteration is necessary. In the early going, the principles of abstraction and cohesion are particularly useful. Students can be guided through simple programs that begin with an abstract idea which is subsequently embellished.

Flowcharts should not be introduced as a programming planning tool. Flowcharting was once a popular programming design method, but its use has led to problems. The first problem with flowcharting is that it imposes too narrow a solution to a problem too early. The second problem is that it encourages unstructured programming to go with unstructured thinking. It is better to use pseudo-language to express the steps required to solve a programming problem in terms of sequence, condition and iteration by working from an abstraction to a concrete model. The idea of cohesion is to promote procedures that perform only one function. Students should be encouraged to write simple, short, one function routines to reinforce the principles of abstraction, cohesion and programming conventions.

When teaching condition, students will begin to see the difference between calculators and computers. The idea of sequential execution of instructions must be firmly implanted to convey the idea of object-time decision making. The structure of the IF statement is also a matter of importance. Several conventions are necessary: First, and most importantly, every IF statement must have a THEN and an ELSE. In no case is an "ELSE-less" IF permissible. An IF with no ELSE is probably the most common pitfall of bad programs (unmaintainable programs). Second, all THENs must be lined up with their corresponding ELSEs. Third, the compound statement (BEGIN .. END) will be introduced here. As with THEN and ELSE, BEGIN and END must also line up. The concept of IF-THEN-ELSE versus cases must be introduced. The teacher must be cautioned to present both versions of compound logic. Perils of case structures must be covered.

Iteration should be handled with the WHILE construction. As with the IF statement, the student must be firmly grounded in the idea of sequential execution of instructions. The logic of the WHILE should be presented without resorting to the REPEAT construction. The REPEAT construction should be avoided for several reasons. First, the REPEAT offers an alternative to iteration, which may be interpreted by the student as an equivalent. Second, the REPEAT construction is more difficult to use because the programmer is not given the option of not iterating - a REPEAT has to executed at least once. After students have understood how to use the WHILE correctly, the REPEAT may be covered as a way to iterate, but should not be offered as substitute for the WHILE.

Having covered sequence, condition and iteration, the student will now be prepared to deal with the software engineering principles of abstraction, information hiding, cohesion and coupling in a practical way. Procedures should be championed as the only way to write non-trivial programs. The syntax and structure of a simple procedure can be presented along with the concepts of abstraction and cohesion. One needs only present a program that has several operations to present procedural concepts. For example, a program that reads three numbers, calculates a mean and displays the result is amenable to three cohesive procedures. Once the idea of procedures is digested, the students can be introduced to the idea of team programming where each team can be given a procedure to write. It is here that the concept of information hiding and encapsulation become evident as programming teams find that they must protect their procedures from other teams. The importance of a parameter list for passing information to and from the procedure is central to encapsulation and low coupling. Procedures should be developed with no global variables as an absolute norm. Many team exercises are possible while teaching procedures and they should all be directed toward good programming with software engineering principles in mind.

Other topics in an introductory Pascal course should follow those mentioned above. In particular, strings are necessary as a basic data structure. Arrays should also be introduced. Files and records are a useful and appealing application; graphics and sound engender interest in writing and exploring the language. While these other topics are interesting in themselves, they are all based on the principles of good programming. In an introductory course, these later topics create interest in programming, but are less important than teaching how to program properly - how to write a good program.

IS PRIOR KNOWLEDGE OF BASIC A DETERRENT TO LEARNING PASCAL

Sue Brown

ABSTRACT

This paper summarizes the results of a study to determine if prior knowledge of BASIC is a handicap when learning a structured programming language such as Pascal. The subjects for this study were 50 high school students enrolled in a beginning course in Pascal. The students completed a questionnaire indicating their prior knowledge of BASIC programming. The relationship between students BASIC background and their final grade in the Pascal course was investigated. A two-way analysis of variance was calculated of students' grades in the Pascal course. The two grouping variables were sex and prior BASIC knowledge. The results of this study suggest that prior knowledge of BASIC is not a handicap when learning Pascal. as measured by the final course grade in Pascal. This study does indicate differences between sex groups in Pascal grades. Females outscored their male counterparts in the Pascal course.

INTRODUCTION

BASIC is the most widely used computer language. More people know how to write programs in BASIC than in any other computer language. However many experts argue it is a mistake to teach any student BASIC. Bork(ref 1) equates BASIC with "junk food" and suggests "arguments for BASIC, fundamentally junk food arguments suggest one should start babies on junk food because there is a lot of it around, and besides if you pick it carefully, it might turn out to be nutritional." ACademic computer scientist Edsger Dijkstra is particularly scornful of BASIC. In an analysis of unpleasant truths, Dijkstra(ref 2) states, "It is practically impossible to teach good programming to students that have had a prior exposure to BASIC. As potential programmers they are mentally mutilated

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beyond the hope of regeneration." There are, however, no research studies to support the claim that BASIC should not be taught.

OUTLINE OF STUDY AND METHODS

Twenty high schools participating in an Educational Testing Service Workshop on Advanced Placement Pascal were contacted. Two schools agreed to participate in this study. Both schools serve a middle to upper class community. Twenty eight males and twenty two females constitute the subjects for this study.

The students completed a questionnaire indicating prior knowledge of BASIC programming. Based upon the questionnaire, students were classified into one of four groups: no knowledge of BASIC, self taught knowledge of BASIC, completion of a 1/2 year course in BASIC, and completion of more than a 1/2 year course in BASIC.

The relation of students' BASIC background to their final grade in the Pascal course was investigated. A tow-way analysis of variance was made of students' grades in the Pascal course. The two grouping variables were sex and prior BASIC background.

RESULTS

Summaries of the two analysis of variance procedures, using BASIC background and sex as dependent variables, are presented in Table 1.

Table 1

ANOVA Summary for Course Grade in Pascal

Source	df	MS	F
Basic Background	3	30.411	.701
Sex	1	174.953	4.033*

*p < 0.05

The results of the analysis of variance procedures indicate a significant main effect for course grade in Pascal for the independent variable sex. The main effect of BASIC background was not statistically significant.

SPACE SCOUTS INTERNATIONAL

A.R.Igoe*, M.C.Radziemski*.

ABSTRACT

This project modified the use of a sophisticated computer simulation program to inform elementary age children about the future possibilities of space stations. The children explored space station technology and assembly, researched the international importance of space exploration and manufacturing, and developed enthusiasm for space activities and international collaboration. Review of the videotapes from the four instructional sessions revealed many exciting interactions among the participants and the tapes became a main focus of the evaluation of the project. Project results indicate that this approach to learning promotes mature decision-making and enthusiasm for the subject matter.

INTRODUCTION

This project demonstrated the modified use of a sophisticated computer software product with elementary age children. The objectives emphasized the international importance of space exploration and manufacturing and promoted enthusiasm for space activities and international collaboration. When children understand the global aspects of space exploration future international cooperation is assured. Recent studies show that American students, particularly females, lag behind their international counterparts in math and science interest. Internationally females are reported to be less motivated and achieve less than boys in science related activities (ref 1). A fifth-grade Girl Scout troop was selected for this project in order to take advantage of the international aspect of scouting and encourage interest in space and science among a group of elementary age females. Since computer use has proven to be a strong motivator in the classroom (ref 2), a computer simulation was chosen to focus the activities of this project. Space M+A+X, from Final Frontier Software, simulates the planning, launching, construction, and operation of a space station based on the NASA space station program.

OUTLINE OF STUDY AND METHODS

SUBJECTS

A troop of 10 Junior Girl Scouts was chosen to participate in the project. The troop has been active for four years and has worked together on many projects. They have grown up in middle to upper middle class families in a large southwestern city.

MATERIALS

Session one. Each participant received a folder containing an attitudinal pre-test, project memo, calendar, agenda, glossary, and worksheet. Specific information regarding their chosen country and modules was given to each individual. Selected videotape footage from an actual shuttle launch was shown.

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Session two. Each participant received a module checklist and list of space station jobs.

Session three. Each participant received two schematic drawings of space station designs, a cutaway picture of several modules of a space station, an artist's rendering of a shuttle docked to a space station in space, and information sheets listing advantages and functions of operational space stations. The Space M+A+X program and tutorials were used in this session, as were laminated cardboard replicas of the individual modules and adaptors.

Session four. A film about the space shuttle and a videotape interview with a NASA mission specialist introduced the session. Each participant received a schematic of their space station design, a vocabulary matching exercise, a project description and worksheet, and post-test.

PROCEDURES

At the first meeting the scouts were given an initial questionnaire which assessed their interest in and knowledge about space. The project was introduced as a simulation: they would participate in Project Delta, an international group formed to plan and coordinate a venture in space. The videotape of space footage was shown. The written descriptions and pictures of the NASA space station modules taken from the Space M+A+X documentation manual, and the definitions of some basic terminology were discussed. The scouts formed five teams, each team representing a different country or group of countries - China, Japan, the European Space Agency (ESA), Russia, and the United States. Information sheets for each country listed its current abilities and interests in space and plans for future space manufacturing and exploration. Each scout chose an individual name which was used for the remainder of the project. The Space M+A+X program divides the space station modules into five minimum configuration and five service modules. Each team chose one minimum configuration module (solar array, heat radiator, command, logistics, or habitation) and one service module (remote manipulator arm, thruster, medical, recreation, and materials processing) to work with and be responsible for.

During the second meeting each team gave a report about the modules they were responsible for. The module checksheet allowed the scouts to compile information about all ten minimum configuration and service modules and the adapter module. To encourage the scouts to develop a more personal involvement with the project each scout chose a job from the job sheet.

The third meeting took place in the College of Education Media and Computer Laboratory at Arizona State University. Each team was assigned a computer and worked through the Space M+A+X tutorial, taking a shuttle launch through the steps of planning, launching, and constructing a space station. Project Delta convened and the entire group was given the assignment of designing, planning, launching, and constructing a single international space station. After a plan was acceptable to all the teams the Space M+A+X simulation was used to construct the space station as designed.

Session four began with a short film about the space shuttle and a videotape interview with Pinky Nelson, a NASA mission specialist. To review prior sessions, the participants completed a vocabulary matching exercise and discussed the answers as a group. Each team was then given a description of a project their chosen country might be interested in pursuing in an operational space station. The teams were separated while they reviewed their materials and discussed ways to convince the other teams to accept their project as one of two chosen by the group for the space station. Project Delta reconvened to discuss each country's project and select two. After the decision was reached the participants completed an attitudinal post-test. The session ended with a recap of the program by the authors and comments from the participants.

RESULTS

Having made the decision to film several group sessions the authors were able to review and evaluate the behavior of the students and construct strategies and guidelines for subsequent sessions.

The general objectives for the participants in the first session were to understand the project, discuss nationalities and modules, learn some terminology, and become enthusiastic about the project. Results of the pre-test showed that all the scouts were very positive in their interest in and liking for math and science and felt that they were competent in them. They appeared enthusiastic and were very interested in choosing countries and appropriate names for themselves.

Objectives for session two were a sharing of knowledge among team members and discussion of individual modules. Each participant completed a module checklist and upon review, all the checklists showed careful attention to detail. The general demeanor of participants in this session was that traditionally associated with classroom behavior. It was interesting to note that the presence of the video equipment was ignored, the participants being totally involved in the discussions.

Completing the tutorial, designing the space station, and constructing the station using the Space M+A+X program were the objectives for session three. Enthusiasm grew as teams completed the tutorial in spite of some frustration due to the complexity of the program. Behavior was consistently on task. After moving to a conference room, the participants continued to function as a team as they placed the laminated pieces together in a functional design. They continually compromised to solve design problems, demonstrating mature group behavior.

After the design phase was complete, the computer simulation was introduced. During this simulation the authors took control of input to avoid delays that might occur because of unfamiliarity with the program. Each launch can only accommodate a portion of the station. Consequently, the multiple launches required continuous group decision-making. Previous positive behavior patterns continued in spite of the length of time required to correct for malfunctions and complete the day's objectives.

For the fourth session, objectives were to demonstrate a knowledge of vocabulary and to make project choices using effective group decision-making skills. Discussion following the completion of a vocabulary exercise showed that all participants had a working knowledge of a majority of the terms used in space projects. When presented with five projects and asked to choose two of them for an operational space station, the decisions were reached efficiently. Observation showed that the same decision-making techniques developed during previous sessions were used by the group. The attitudinal posttest results showed high levels of enthusiasm for learning more about space activities and an increase the space-related knowledge base.

It is the opinion of the authors that there is much to be learned from this project. The world the students of today will enter when they leave school is one which requires teamwork and decision-making. With proper knowledge and strategies, each person can take responsibility for activities in the work world which are personally satisfying and valuable to the community at large. We venture to say that a project such as this, integrated into the elementary curriculum and extending over a semester or a year, would provide an opportunity to exercise both the academic and interpersonal skills which are essential to the adult of the 21st century.

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COGNITIVE BEHAVIOR AS THE CHILD INTERACTS WITH LOGO LEARNING

L.C. Fagundes*.

ABSTRACT

This study was motivated by two questions: the use of the computer as a tool in education and the psychological theory itself which underlines the evaluation of its use. In order to do this we have chosen Piaget's psychogenetic theory. The analysis of the subjects' performances in programming activities has showed different levels of the cognitive mechanisms. These levels have changed while the programming activities occured.

INTRODUCTION

This study investigates the nature of the cognitive behaviors which appear when the child is programming in a LOGO learning environment. The use of the computer in education needs to be based on a psychological knowledge which explains the mechanisms used by the child while learning. Jean Piaget's psychogenetic theory and the LOGO were chosen to limit the field of investigation. Such theory studies the construction of knowledge based on facts: the child's cognitive behaviors. The operative level of the mental structures is expressed by cognitive competences. The inteligence operates as a special function of the individual's adaptation to the environment. The different levels of competences change through a dynamic process of equilibration between the functions of assimilation and accomodation. This process of new equilibrations on more advanced levels is especially due to a reflexive abstraction process. According to this approach we have raised the following questions: - Can the process of reflexive abstraction be improved by the exchanges with symbolic objects - the programs - in the LOGO learning environments? - How can the process of pseudo-empirical abstraction during the programming activities support the construction of new signification systems?

OUTLINE OF STUDY AND METHODS

The methodology covered the Ss' spontaneous programming activity in individual sessions when they were "clinically" questioned by an interviewer. The questions were made in a dialetical sequence in order to produce exploration and explanation behaviors, and above all to activate S's critical thinking. The interviewer provided programming aids for exploration when the Ss demanded. The Ss were free to always devise their own goals. The sessions

were described by an observer. The subject's production was stored in diskettes. A group of 26 Ss, aged 5 - 18, worked twice a week an average of 23 one-hour sessions, in LOGO environment.
The piagetion clinical method was used in order to collect the informations as it follows:

- the S's meanings for each command or procedure
- the S's hypothesis
- the sort of information chosen by the S
- how the S link is one information to another
- how the S coordinates the relations stablished
- the S's comprehension of feedbacks
- the S's inferences
- the S's explanations of the differences between the obtained results and the pretended ones
- the S's decision processes: what coordinations have been made? what sort of regulations have been made.

RESULTS

The analysis of the data allowed to design a 3 - phase-model, the two first phases consisting of two sub-phases. Only the younger Ss started at the first phase. Some older ones went through this initial phase during the first or the second session. The difference in reaching more advanced phases is related to the amount of time the subject interacts at LOGO environments. The younger Ss need a larger amount of time than the older ones.
The following cognitive competences are related to each phase:

Phase I - Representation of the Ss action through the LOGO procedures
Phase I A - The answer of the machine is an extension of the Ss action
Phase I B - The LOGO commands make the computer represent the Ss own sensory-motor action
Phase II - The activity of programming produces a symbolic object
Phase II A - The program becomes an unchangeable set of unstructions which have already been experienced, without debugging
Phase II B - The program is a symbolic object produced by the Ss activity who build up a totality formed by parts (the procedures) which present the possibility to be manipulated
Phase III - To program is to build possibilities, to make different combinations, to test hypothesis, to experience new ways, and to coordenate possibilities.

These cognitive competences appear through succesive compensatory

regulations in the Ss' activities as a result of their own pseudo-empirical and reflexive abstraction processes.
These regulations make a continuum of new differentiations and reintegrations about the observed by Ss themselves concerning their own actions. It needs to be a spontaneous activity which is oriented by the structure of the environment and supported by the clinical method used by the monitor.

TECHNOLOGY AND TEACHER EDUCATION: MOVING FROM "TALKING ABOUT" TO "INCORPORATION"

Dee Anna Willis[1] and Jerry W. Willis [2]

ABSTRACT

The uptake of technology in colleges and schools of education has been relatively slow compared to the uptake in many other disciplines. Reasons for this are discussed. A four stage model of technology diffusion in teacher education is described.

Teacher education is simply not a major participant in most of the current high profile software development and dissemination projects for higher education. For example, of 1687 separate projects supported through IBM's Advanced Education Project (Danielson, 1987), only 3% dealt with professional preparation of teachers. In addition, Kinko's extensive list of software contains no software for teacher education, and none of the EDUCOM NCRIPTAL awards for innovative educational software have gone to teacher educators. Teacher education's low level of involvement is somewhat ironic because many public schools have invested heavily in computer technology. In some areas the schools are far ahead of colleges and schools of education (CSE) at local universities. In fact, many teacher education faculty now find themselves in the odd position of urging teacher education students to use technology while using very little, if any, technology themselves. The limited participation is also surprising because the professional focus of CSE is the design and delivery of effective, efficient instruction. This paper explores some of the reasons for the limited participation of teacher education in instructional computing and suggests ways of increasing the rate of involvement.

TECHNOLOGY DIFFUSION AND DISSEMINATION

Technology diffusion can be thought of as a sequence of stages. Each stage has certain characteristics and certain problems that must be overcome in order to progress to the next stage. However these stages are not sequential, they are cumulative. The issues and activities of a new stage do not replace those of an earlier stage, they are simply added to the issues, problems and activities of stages that began earlier.

THE NO-USE STAGE

A few CSE have not progressed beyond this stage. The faculty and administration are aware of instructional computing, but computers are not yet significant topics of instruction or tools for instructional delivery. CSE can progress from this stage in one of two general ways. Many CSE are influenced by **External Influences** (top down) that push them toward using computer technology. In Texas, for example, a new state regulation required all CSE to provide students at least one educational computing course.

Other CSE progress from the No Use Stage by **Internal Influences**. In some instances the influence comes from administrators such as the dean (top-down influence). In others the push comes from individuals or small faculty groups (bottom up). External influence, internal top-down influence, and bottom-up influence all pose significant problems.

Critical Elements in Top-down Influence. The top-down model of diffusion is popular, and it often fails. One reason is the role *ownership* plays in the success of an innovation. Most educational innovations, including instructional computing innovations, are oversold. They require major adjustments by faculty, they rarely work properly without extensive debugging, and the promise of more effective instruction with less effort is rarely, perhaps never, achieved. There are benefits, but faculty generally find they spend at least as much time, often more, when they use the computer.

An innovation with these characteristics rarely makes it past the experimental phase when it is implemented by administrative fiat. Only faculty who are invested in the project, only faculty who see it as their own project, will be willing to invest the time and effort required to debug an innovation and successfully implement

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it. If faculty ownership of an innovation is crucial, is there any possibility that a top-down approach will work? It will work if what comes down from the top is a general plan of attack instead of a specific, detailed set of directives. Faculty *must* be involved in developing the specific plan or innovation. An excellent plan that is disliked and rejected by faculty will not be successful while a good plan, even with significant flaws, that is *owned* by the faculty may be very successful.

Top-down influence also requires continuing encouragement and support by the administration. In later stages movement may slow, even stagnate, without continuing support.

THE TALKING ABOUT STAGE

In this stage, the advantages of using computer technology are recognized, at least vaguely, and elements of the CSE begin to discuss what can be done, what resources are needed, and methods of acquiring the resources. For many CSE this is a very discouraging stage. In tight budget situations, funds for computers are scarce. Few CSE have large budgets for equipment, and without a history of significant purchases of computer equipment university officials find it difficult to accept the computer needs of CSE on the same basis as they do the computer needs of departments with long histories of computer purchases. Many CSE also plunge into computerization without evaluating the need for faculty training. To progress beyond this stage, the CSE must avoid these problems and develop effective support strategies.

THE LONE ARRANGER STAGE

Another common stage is one where a few interested faculty devote time and energy to developing instructional computing applications. They arrange their time, their classes, and sometimes their research focus, in order to develop, use, teach about, and evaluate computer-based instructional methods.

Most CSE today are in this stage. A few faculty have become the designated "computer types." They may even teach one or two educational computing courses,but the great majority of CSE faculty have little, if any, involvement with instructional computing.

Critical Elements in Bottom-up Influence. Individual innovators and small innovation groups may form and survive for short periods without administrative support, but good projects can take years, not months, and few informal teams can survive long without the support and encouragement of fellow faculty members and administrators. Such support and encouragement is frequently absent or is not sufficient (Maddux, 1988; Oppenheimer and Winer, 1988). Oppenheimer and Winer, who spent four years on a successful instructional software development project with outstanding resource support, decided to pass up an opportunity to continue their work. That decision was due, at least in part, to the lack of social and organizational recognition for their work.

Some administrators may be highly critical of projects that seem simplistic and poorly conceived. Nonetheless, a faculty members' simple drill and practice program may be the first step toward a sophisticated ICAI program. Gibson and Nolan's (1974) four stage model of data processing growth begins with the use of simple programs to solve routine problems. By the fourth stage, however, the applications are much more complex and may involve sophisticated uses such as simulation models and query systems. A similar simple-to-complex stage model probably applies to instructional computing innovations. Without support and encouragement of movement toward the ultimate goal (i.e., successive approximations), many faculty will abandon their efforts long before they reach the goal.

THE STAGE OF INCORPORATION AND DIFFUSION

In this stage, most faculty understand the roles computers can play in their specialty areas. Many use computers in their courses, and teacher education students learn ways of using computer technology in many of their courses. Computer technology is incorporated into the daily life of the CSE and diffused into most areas of the CSE. Teacher education students learn about instructional computing in many different classes and CSE faculty serve as models of computer-using-educators.

Few CSE today have reached this stage, and fewer still remain in this stage. As Maddux (1988) has indicated, at least some CSE that reach this stage regress for a variety of reasons. One of the most common problems encountered in this phase is maintaining momentum.

The reasons for loss of momentum are many, but prevention is much easier than a cure. Perhaps the most important preventive measure is the help you can provide participants in setting *realistic goals* . Over and over again, faculty report that they were amazed at the time and effort their project took . Setting realistic goals, even if it means the goals will be much more modest than desired, is essential (Trollip, 1987).

Another preventive measure is a *support group*. Participants who work alone without contact with participants in other projects, are more likely to fail or abandon the project. A support group that meets bi-weekly or monthly does not take a great deal of time and it can provide the type of collegial support, encouragement, and advice participants need when they encounter problems. Keep in mind, however, that a support group should be made up of practitioners with similar backgrounds and similar experiences. Weight Watcher's support groups are not made up of one or two overweight participants and fifteen or twenty svelte dietitians. Support groups for innovation projects should not be made up of one or two faculty and fifteen or twenty programmers (Gardner, 1988).

Two final preventive measures are *appropriate software support* and *appropriate information resources*. Most of the faculty in some disciplines are experienced programmers. They can develop their own instructional software using traditional computer languages. Instructional software has been written in virtually every programming language. Coding can become a major stumbling block though, when inexperienced programmers attempt to use standard programming languages (Hazen, 1987). Newer authoring systems like Course of Action, Guide, ScriptWriter, and Scenario as well as HyperCard are relatively easy to learn (at least compared to the effort required to learn PASCAL, Prolog, or Lisp) and can be used by non-programming faculty to create powerful instructional software. Many inexperienced faculty will need help with the selection of an authoring system.

Finally, faculty should have access to appropriate information resources. At many colleges and universities, faculty often find their university library does not have many of the relevant journals. Access to relevant journals as well as opportunities to attend conferences provides faculty with up-to-date information.

GENERAL BARRIERS TO TECHNOLOGY DIFFUSION IN TEACHER EDUCATION

In this section, we will discuss some of the common problems CSE must deal with in all four diffusion stages.

Failure to Use The Professional Literature on Change

Expanding the number of faculty who use instructional technology is not simply a technological process. It is more than making the hardware and software available. It is much more a psychological, a social, and an educational process (Lucus, 1978). The failure to recognize *diffusion* as a human and social process is a major impediment to expanded diffusion. Many faculty and staff with academic computing expertise have very little, if any, training in fields such as organizational development and the consultation process. Many seem to be completely unaware of the research and professional literature on organizational change and diffusion. The literature on diffusion (Ostlund, 1974; Stewart, 1982) is a valuable source of helpful information. Connor and Lake (1988), for example, discuss many different methods of facilitating organizational change from a business perspective. Chen and Brovey (1985), who work in the Computers in Education Research Laboratory at Tel-Aviv University, focus on instructional computing in educational institutions. For them the process of introducing technology is a complex one that, if it is to be successful, calls for an understanding and application of the *social technology* of change. For a comprehensive review of the research on innovation and change see Tornatzky, et. al (1983) and Tornatzky (1983). The process of facilitating instructional computing on a university campus requires an understanding of both computer technology and social technology. If we lack information about either we are not likely to succeed.

Culture Clash and The Teacher Education Faculty

Computer technology is an inherent part of the everyday academic life of faculties in many of the sciences. Most teacher educators, on the other hand, do not have extensive computer backgrounds. Acquiring the skills necessary to become a computer-using educator demands a considerable commitment. Because those who must commit the most time have had the least exposure to colleagues who serve as computer-using role models, it is also something of a leap of faith. The result is a significant barrier to diffusion.

In discussing the problems of faculty from the "soft" disciplines who are now considering instructional computing Weissman (1987) points out that the "kind of algorithmic formalism found in much computing documentation is ... considered alien and hostile to the spirit and culture of the academic communities ... of these new users." He argues that we must change that before the hard and soft disciplines have equal access to computing resources. "Many of the computing architectures maintained on large campuses still require the hacker's spirit.... Systems that require the user to become a hacker must change substantially if they are to find acceptance by the new user." Without access to user-friendly systems, many teacher education faculty will not pursue instructional computing.

The Academic Computing Staff Doesn't Understand

Although teacher educators who need help should have no trouble getting it from the academic computing staff, that is seldom what occurs. Faculty in the sciences are more likely to receive appropriate assistance from the staff of most academic computing centers. The staff of many academic computing centers are more familiar with the problems of instructional computing in the sciences than in the humanities, the arts, and the professional schools such as CSE. At least some members of the academic computing staff should have a background and interest in (and be responsible for) instructional computing in fields such as teacher education.

Some are skeptical about the possibility of expanding traditional academic computing services to include the specialized knowledge needed by the soft disciplines. If that is true, we need a multi-tiered system of computer support. Central academic computing services could provide general support and expert trouble-shooting help, but many of the support and consultative services would be provided by specialized discipline-specific centers. Duke University's Humanities Computing Facility is one example. Other universities including the University of Maryland (Weissman, 1987) have established similar facilities for different disciplines. The University of California at Los Angeles, for example, has developed a comprehensive Social Sciences Computing system.

The Reward Structure May Work Against Innovation

The teacher educator who decides to use computers to deliver instruction may be surprised by the meager number of programs currently available in this discipline. Although there are a number of programs in fields such as special education and counseling, many other fields in teacher education have few, if any, canned programs available. Interested faculty in those areas face the prospect of developing their own programs. Such an effort takes time, a huge amount of time, and professors, especially junior professors without tenure, must be concerned with the twin issues of whether their work makes a contribution to their discipline and whether their work will be valued by the people who make decisions about tenure, promotion, and merit salary increases. In many colleges and universities, the reward structure discourages both the development of educational software and the use of computer technology for instruction. Several faculty who have created excellent instructional software at research institutions, for example, say their efforts have actually reduced opportunities for advancement because the committees that evaluate their professional productivity do not feel their software efforts are relevant (Trollip, 1987). Without a reward structure that encourages development, instructional software in many fields of teacher education will remain virtually nonexistent.

Lack of Equity in Funding for Equipment

On many campuses where the decisions on allocation of computer funds are made by administrators from the traditional computer-using disciplines or by committees dominated by these disciplines, most of the available funds will be spent on equipment and services that best serve those fields. That outcome is often justified on the grounds that there are legitimate, pressing needs that must be addressed in those fields. That is a convenient justification, but it is not sufficient. There are never enough funds to meet even a majority of the legitimate, pressing needs. A real need should be a necessary condition for funding, but it is not a sufficient condition. Where two pressing needs exist (e.g., a computer lab for teaching PROLOG and a computer lab to teach teacher education students classroom management skills) and enough funds to meet only one need, the process of deciding which need to meet is often a political one. On most campuses it is far more difficult to obtain funding to establish a model teacher education computer lab than it is to add equipment to an existing computer science lab. It is not a matter of which need is greater, it is a matter of who controls the purse-strings.

The Tyranny of an Illogical Bureaucracy

On many campuses faculty are well aware of the problems inherent in making even a simple purchase of computer equipment. When faced with the likelihood that a significant computer purchase may involve a major time investment as well as the significant risk that funds may be recaptured by the central administration because the purchase could not be made before the end of the fiscal year, many faculty decide to spend available funds of something else. Hardware and software should be no more difficult to purchase than an overhead projector or a set of educational videotapes.

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DEVELOPING AN INFORMATION TECHNOLOGY COURSE FOR PGCE STUDENTS

Maurice Hart *

ABSTRACT

A course for training new post graduate teachers now includes a specialist Information Technology element. Planning for this element has to take into consideration the sometimes limited experiences of the graduates and the varied nature of the teaching that will be required of them. Different methods of approach have been tried and evaluated.

INTRODUCTION

University graduates in England qualify to teach students aged eleven to eighteen by taking a one year course known as the Post Graduate Certificate in Education (PGCE). There are other ways of qualifying to teach this age group, but the PGCE entry is easily the most common. After taking a PGCE graduates become specialist teachers in one or two academic subject areas. Sometimes one of these subjects has a slightly lower status within the PGCE and is known as a "second main" subject. With the growth of the use of Information Technology (IT) in secondary schools, both as a tool for teaching and learning and as an area of study, there is a need for many more teachers to become qualified to work in this field. One way of achieving this is by making IT available as a second main academic subject in PGCE courses. This paper describes the way in which one of the first "PGCE second main IT" courses was planned. The paper also notes difficulties encountered and modifications tried.

DIFFICULTIES AND NEEDS

There are two main areas of difficulty in planning an IT course for PGCE students. The first is the very wide range of both the uses of IT within schools and courses that embody IT as an area of study in the education of 11 to 18 year old students in the U.K. The second problem, which is to some extent related, is that at present IT is not an accepted and known body of knowledge like say Geography or Mathematics. The experiences of IT that students have on their degree courses are therefore not in any way similar in either content or level. This diversity means that in terms of direct knowledge many of the PGCE students on these IT courses will never have used some of the aspects of IT encountered in schools such as Desk Top Publishing or LOGO for example. In order to be effective in school there are three essentials that the students need to know.

These are:

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(1) Methods of enabling children to learn how to use different aspects of IT

(2) Ways that the use of IT can be incorporated into teaching and learning in the classroom

(3) Content, levels, and methods in relation to IT as an area of study

LEARNING HOW TO USE INFORMATION TECHNOLOGY

In general the methods of approach to the teaching of the PGCE IT course follow from these and take into account the PGCE students' own lack of knowledge about some aspects of the use of IT. A way of summarising the method of approach to (1) above is that two tasks have to be tackled at once. The PGCE students have to acquire technical expertise, while also considering ways of helping school students to reach the same goal. The use of different systems and applications by the PGCE students is therefore based on trying different methods of approach with them and considering the advantages and drawbacks of each for different ages and ability levels. For example in order to acquire proficiency in wordprocessing it is possible to learn by many different methods. A very common method is to work through a highly structured user guide on a specific system (like Wordstar) that does not attempt to explain principles. Similarly some teachers use a "battery hen" mode where students sit at keyboards and type the commands and text given by the teacher, keeping all at the same pace, until a certain level of proficiency is reached. Other teachers try to explain general principles and then allow the students to type in their own text on a trial and error basis. Less structured individual userguides can also be written to work in this way. For the PGCE course suitable resources have to be available so that they can try these different methods of approach for their own technical development. The students themselves can then generate lesson plans, worksheets etc. for the classroom based on their own experiences.

INCORPORATING I.T. INTO THE CURRICULUM

An analysis of the ways that children learn and how this could be affected by the use of IT fits naturally into this way of working and leads on to an in-depth study of (2) above. This aspect has an added importance because, given the shortage of teachers who have made any study of the effects of the use of IT on teaching and learning, the PGCE students will certainly be asked to help others, as well as being expected to incorporate the use of IT into their own teaching. Much of this aspect of the PGCE IT course is similar to work done in other PGCE subject courses. Different uses of IT have to be categorised; the availability of software and methods of classifying and evaluating software have to be discussed; the range, numbers and distribution of resources have to be considered. Specific uses within the classroom also need to be related to the different theories of learning that the PGCE students are discussing in the Education element of the PGCE course. As an example, the use of wordprocessing in the classroom and by individuals is studied from different perspectives. These include; product/process possibilities, differences for individuals and group work, motivating factors, possible effects on oral and written language development.

INFORMATION TECHNOLOGY AS AN AREA OF STUDY

Given several weeks work on the areas as described above a consideration of IT as an area of study can then be approached from a common set of experiences. In general three possible methods of approach are identified. These are:

(1) Starting from skills and knowledge related to particular items of software/hardware. Use of a particular database on a specific system for example, or more possibly the use of a particular programming language like LOGO, BASIC, or PASCAL.

(2) Starting from an application, this may be databases again, but from the point of view of how they are used, and in what circumstances, rather than the technical process of setting them up in the first place. A particular example of applications is using IT within design technology for monitoring and control activities.

(3) The third method identified with the PGCE students is to start from an "external" situation that involves the use of IT, some examples are; travel agents, banks, credit agencies, publishing. This involves the idea of a case study and also the involvement of many different applications. It also involves an in-depth consideration of the impact of IT on the functioning of society.

In the U.K. it is possible for school students to take accredited courses that are mostly skill based, or that are theoretically biased, or that rely on the use of case studies, though most include a mix of these three elements. With the PGCE students a selection of these courses is analysed. The students are then expected to prepare schemes of work that relate to the elements of a course of their choice.

EVALUATION

In general the methods of working described above function effectively. The students enjoy the IT aspect of their school contact time and, though often starting the year with a feeling of total insecurity, find that they are easily able to work in school at the required levels. They also find that this qualification is very welcome when they apply for teaching posts, even to the extent of being given considerable responsibilities for IT in their first post. Course evaluation has also been mostly positive but initially it was found that some students, who had worked extensively with computers on their degree courses, had problems in terms of perceptions. In particular such students seemed to find it difficult to see the necessity for considering different ways of approaching the use of IT in schools. They became impatient when using "low level" software, and found it hard to appreciate the difficulties that others might have. A quote from the evaluation of a student on the first cohort was "We are not psychologists, and want practical things not theoretical". For the next cohort the course was modified to allow for more individual choice within sections and to provide earlier school contact time, with the whole group working with school classes at various levels. While this has given all the PGCE students more of an understanding about what happens in school and the necessity of studying ways that children learn, it is very time consuming and cuts down on the number of areas of IT that can be studied in any depth. The need for PGCE IT courses is very obvious, but they will need to be evaluated carefully in the light of changing sets of skills of entrants. They will also need to be flexible in content and methods of approach.

USING COMPUTER GRAPHING TO IMPROVE MATHEMATICS INSTRUCTION

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ABSTRACT

Computer graphing can be used to enhance the teaching and learning of mathematics. More realistic problems and deeper mathematics are possible with the aid of technology. Geometric representations of problem solutions are easily added to the usual numerical and algebraic representations.

INTRODUCTION

Technology available today can dramatically change the way mathematics is taught and learned. The technology based approach to the teaching and learning of mathematics described in this paper has been piloted for the past two years in The Ohio State University Calculator and Computer Precalculus (C^2PC) Project (ref 5). C^2PC teachers are using two important technology driven instructional models. Students participate in an interactive lecture-demonstration instructional model in a classroom containing a single computer. Computer laboratories and classrooms where students have graphing calculators provide a setting for a guided-discovery instructional model. Teachers use a carefully prepared sequence of questions and activities to help students understand or discover important mathematical concepts.

REALISTIC APPLICATIONS

Realistic problems are accessible to students much earlier in their study of mathematics through the use of technology. Lack of familiarity or facility with algebraic techniques need no longer be a barrier to quality problem solving activity by students. The first example is an annuity problem with no closed form solution that is accessible to algebra students.

Example. A couple can afford to pay \$600 per month for a 25 year home loan. What APR (annual percentage rate) interest rate will permit them to purchase a \$65,000 home?

Solution. Let x be the *monthly* interest rate. Then $12x$ is the APR rate. Waits (ref 7) showed that equation (1) is valid.

$$65{,}000 = 600\frac{1-(1+x)^{-300}}{x} \tag{1}$$

Because there is no closed form solution to (1), a numerical method is required to find a solution. In fact, a graphing based method is quite natural. One way to solve $f(x) = g(x)$ graphically is to simply graph $y = g(x)$ and $y = f(x)$ in the same viewing rectangle, a rectangular region $[L,R] \times [B,T]$ of the coordinate plane, and then look for points common to both graphs (points of intersection).

Let $f(x)$ be the left-hand side and $g(x)$ the right-hand side of the above equation. In this problem it is particularly important to choose a reasonable first viewing rectangle. The problem situation indicates that we need only graph f and g in the first quadrant. (Why?) It must be established that the y values represents possible dollar amounts for the loan. Thus, the maximum y value for a viewing rectangle must be greater than 65,000. Because x is a monthly interest rate, it

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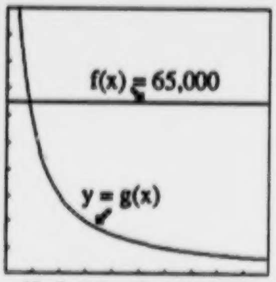
is reasonable to assume x is less than 0.1 (10% per month). Figure 1 shows the graphs of

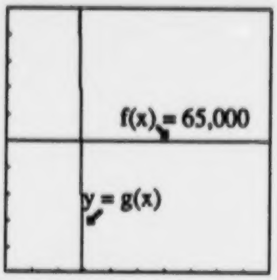
$$f(x) = 65{,}000 \quad \text{and} \quad g(x) = 600\frac{1-(1+x)^{-300}}{x}$$

in the [0, 0.1] by [0, 100,000] viewing rectangle. The graphs in this paper were produced by a graphing program written by the authors (ref 4). That there is only one solution is readily apparent. The graph in Figure 1 suggests x is about 0.01. A graphing based zoom-in procedure (ref 6) can be used to determine that the monthly interest rate x is 0.008503 with error less than 0.00001 as shown in Figure 2.



[0, 0.1] by [0, 100,000]

Figure 1: Annuity Problem



[0.0085, 0.00851] by [64999.5, 65000.5]

Figure 2: Anuity Problem, Zoom-in View

Thus, the desired APR rate of the home loan is 10.20%.

MULTIPLE REPRESENTATIONS

Computer or calculator based graphics make the addition of a geometric representation to the usual numerical and algebraic representations very natural. The ability to quickly obtain a graph of $y = f(x)$ makes it very natural to discuss the geometric interpretation of solving the equation $f(x) = 0$. Furthermore, the zoom-in procedure used in the previous example can be used to solve equations and inequalities that are not accessible to students with only algebraic techniques. Solving inequalities soon becomes a geometric problem of finding when one graph is above or below another, or when one graph is above or below the x-axis. The easy availability of a geometric representation gives students and teachers the opportunity to explore and exploit the connections between algebraic and geometric representations. The next example illustrates these important connections (ref 3).

Example. Squares of side length x are removed from a 25 inch by 40 inch piece of cardboard (Figure 3). A box with no top is formed by folding along the dashed lines in Figure 3.

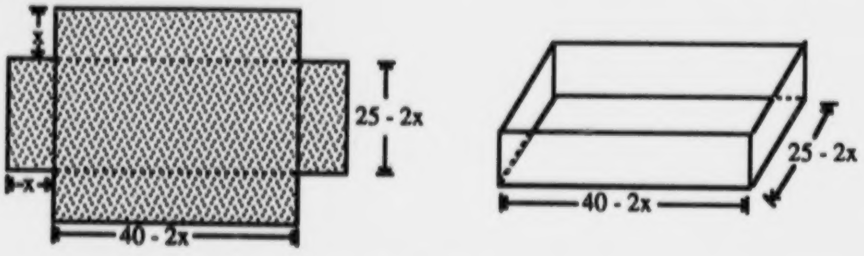


Figure 3: Box Prob

(a) Express the volume V of the box as a function of x.

(b) Draw a complete graph of the algebraic model V.

(c) Which portion of the geometric model (graph) in (b) represents the problem situation.

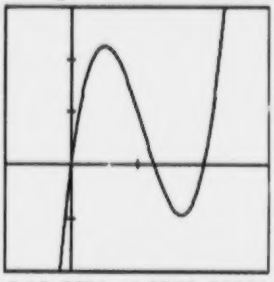
(d) Determine x so that the box has maximum possible volume and find this maximum volume.

Solution.

(a) The formula $V = LWH$ can be applied to obtain the volume V as a function of x. The height is x, the length is $40 - 2x$, and the width is $25 - 2x$. Thus, $V(x) = x(25 - 2x)(40 - 2x)$ is an *algebraic representation* of the volume as a function of x.

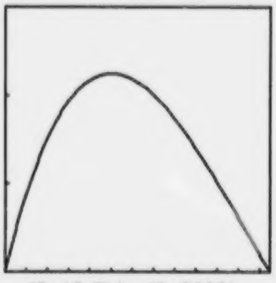
(b) A complete graph of $y = V(x) = x(25 - 2x)(40 - 2x)$ is shown in Figure 4. Students will need to experiment with different viewing rectangles until a complete graph is determined. Students would be expected to have had considerable computer based experience graphing cubic polynomials before investigating this problem.

(c) The physical limitations inherent in removing a square of side length x implies that x must be positive. Because the smaller side of the rectangular piece of cardboard is 25, $2x$ must be less than 25, or x must be less than 12.5. Thus, the values of x that make sense in this problem situation are $0 < x < 12.5$. This means that only the portion of the graph in Figure 4 in the first quadrant that is above the x-axis with $x < 12.5$ represents the problem situation. Therefore, the graph in Figure 5 is a *geometric representation* of the problem situation.



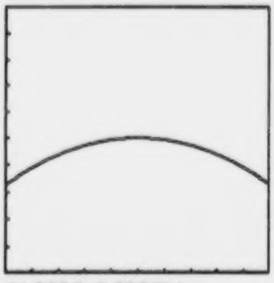
[-10, 30] by [-2000, 3000]

Figure 4: Box Prob, Alg Rep



[0, 12.5] by [0, 3000]

Figure 5: Box Prob, Geo Rep



[4.9995, 5.0005] by [2249.99995, 2250.00005]

Figure 6: Box Prob, Zoom-in View

(d) Figure 4 strongly suggests that there is a maximum value of V of about 2300 and it occurs when x is about 5. We find that considerable discussion is necessary for students to readily associate the coordinates of the "maximum point" with a solution to this real world "maximization" problem. First, the connection between the coordinate representation of points (a, b) of the graph of V and $b = V(a)$ must be established. That is, in (a, b), a represents a possible side length of a removed square and b the corresponding volume of the resulting box only for certain values of a and b. Such discussion helps establish the connections among the graphical representation, the algebraic representation $y = V(x)$, and the problem situation representation. Now, if (a, b) are the coordinates of the highest point, students can see that the maximum volume is $b = V(a)$ and a is the side length of the removed square. Such connections must be carefully developed with many examples during the school year. Once this kind of activity is well established, it is easy to move to zoom-in as a procedure for determining very accurate solutions to these types of problems. Figure 6 illustrates the last viewing rectangle used in a zoom-in process. The figure shows that the volume is 2250 with error at most 0.0001 and the associated value of the side length of the removed square is 5 with error at most 0.001. In this case, it is not surprising to find that 2250 and 5 are exact answers.

The easy availability of geometric models makes multiple representations of problem situations possible. Analyzing the problem situation through both algebraic and geometric representations deepens student understanding about the problem situation. Instead of the usual negative attitude about word problems, students gain more confidence about problems with the added technique of analyzing and solving them graphically. Word problems seem less mysterious and not as formidable with the addition of a geometric representation and powerful graphic problem solving methods.

PROBLEM SITUATION REVISITATION

We believe there is great benefit to students when a problem situation revisitation approach to instruction is used across "courses" as well as within courses. For example, the previous volume problem can first be explored in *middle* school mathematics classes by measuring and creating real physical paper models. Prealgebra and Algebra I students can return to the problem numerically and use tables to study the problem and establish the concept of variable (ref 1 & 2). Advanced Algebra students can return to the problem and obtain a geometric representation of both the problem situation and the algebraic representation with computer graphing. Precalculus students can then use zoom-in to geometrically solve related maximum and minimum problems. Finally, when students see this problem again in calculus, they will have a rich, intuitive, geometric basis to apply the rigorous, formal techniques of calculus.

SUMMARY

Technology gives rise to interactive instructional models that permit a focus on problem solving. The new instructional approaches possible with the use of technology make teachers and students active partners in an exciting, rewarding, enjoyable, and intensive educational experience.

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A COMPUTER LABORATORY FOR TEACHING TEACHERS

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ABSTRACT

A Teacher Education Computer Laboratory, funded in part by a grant from the National Science Foundation, has been developed to provide teachers with hands-on instruction in the operation of computers and computer-related technology, and in the integration of these tools into the daily classroom curriculum. Two courses (one each for elementary and secondary teachers), have been added to the teacher education curriculum to fulfill these needs. Actual instrumentation of the lab includes three different microcomputer environments, cd-ROM, laser technology, interactive video, networking and so forth. Specially designed activities help both in-service and pre-service teachers to augment and partially replace the more traditional lecture/ demonstration/ overhead approach to teaching with a broad variety of computer aided and computer managed techniques.

INTRODUCTION

The Teacher Education Computer Laboratory was designed and equipped to provide hands-on laboratory teaching experience for students in three distinct computer education programs: 1) required professional training for all pre-service teaching students; 2) methodological enrichment and innovation for in-service teachers; and 3) teacher certification and endorsement in the Computer Science discipline. Courses in these programs incorporate extensive and active laboratory experience in order to prepare prospective teachers for effective classroom environments in both primary and secondary schools.

Working in the Teacher Education Computer Laboratory, students are encouraged to augment and partially replace the more traditional lecture/ demonstration/ overhead approach to teaching with more exciting, instructionally sound computer techniques. In this way they gain an appreciation for active learning rather than for passive listening and note taking. Furthermore, they are exposed to a teaching environment which integrates experimentation into the abstract principles of many disciplines. Our students learn by actually working with the machines, gaining experiences that will serve them as models in their teaching of primary and secondary students later in their careers. Thus they can help others learn to integrate abstract concepts into concrete projects and lead them to successful project completion.

HARDWARE SELECTION

In many school districts the original instructional computing equipment consisted of Apple microcomputers which are now beginning to wear out and which now

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must be replaced and augmented. The selection process is a difficult one because of the high cost of hardware and the proliferation of choices on the marketplace. Nevertheless, four or five configurations seem to dominate the educational computing scene:

(1) machines of the IBM-PC (MS-DOS) family, selected to make the educational laboratories compatible with the machines most widely used in the business world. With the current emphasis in education on job training and skills, this will be an attractive choice to many school administrators.

(2) the Apple IIgs, which promises to be the new leading edge of educational computing technology, and which allows much of the software already on hand for the Apple IIe to remain in use.

(3) the Macintosh, whose design philosophy of graphic interfaces between machines and their users represents a unique teaching tool.

(4) the Commodore family of computers (64, 128, Amiga) originally selected for schools because of their relatively inexpensive cost and ease of use, and now maintained to preserve the value of the initial investment in purchasing them.

(5) the Atari, selected primarily because of its excellence as a graphics machine and the large selection of educational software (especially on the primary levels) available for it.

The Teacher Education Computer Laboratory is equipped with a mixture of three of the above microcomputer environments: the MS-DOS family; the Apple II family; and the Mactintosh series computers. Apple IIgs machines were chosen as the most advanced technology in the Apple II family. Although the IIe is significantly more heavily used, its technology is dated and no longer represents the leading edge of educational computing equipment. The choice of the Macintosh series systems was predicated on both the existence of a large amount of educational software and on the paradigm of the icon as a conceptual program tool. The selection of the MS-DOS family systems permits prospective teachers to be exposed to hardware and to software that is already pervasive in all sectors of our society: industry, business, education and the private home.

PERIPHERAL TEACHING TOOLS

A major goal of this laboratory is to enable our students to develop and present study units on various content area concepts, sampling the broadest possible range of state-of-the art computer methodology. To facilitate this goal, the entire laboratory has been networked to allow sharing of software, data, storage and printing resources, using the AppleShare Network system with a Macintosh II file server. Memory resources include an eighty megabyte hard disk on the file server, a cd-ROM player and an interactive video laser disk player. An additional external hard disk can be added to network as needed. Print resources include five Apple Imagewriter II printers, with spoolers controlled by the file server. A Laserwriter can be added at a later date.

Supporting the video disk player is a 27 inch color stereo high resolution monitor. Additional video equipment sharing this monitor include a Video Cassette Recorder and a portable camcorder. Two LCD projection devices and a low heat overhead projector can be used either with the above video equipment or connected to various computer stations in the room. Sound production is provided by a Farallon voice recorder and two high performance speakers. Rolling carts provide mobility and portability for all video equipment.

SOFTWARE SELECTION

The most difficult task in equipping the Teacher Education Computer Laboratory has been the selection of software. The two major complications are the proliferation of packages available and the often questionable networkability of these packages. Over 100 selections have been made to date, however, falling into three general categories:

1) Teacher Tools -- This group includes grade books, test generators, outliners, authoring packages, puzzle makers, lesson planners, etc.

2) Instructional Software -- Care has been taken to ensure that a variety of software is available for all K-12 grade levels as well as all content areas common to public school curricula and all computer teaching techniques. Wherever possible, identical or similar packages have been chosen for all three environments to allow for comparison studies.

3) Programming Software -- Compilers and interpreters for several programming languages are included to allow students experience in writing and modification of instructional software. Languages chosen are those most commonly used in educational settings (BASIC, LOGO, Pascal) and those frequently employed to write instructional software (C, Prolog, LISP)

CONCLUSION

The preparation of quality teachers for our public schools needs intense support. Prospective teachers must receive a sound theoretical and practical grounding in subject area disciplines as well as a functional and creative approach to classroom teaching methodology. Current technology offers teachers an unsurpassed variety of effective teaching techniques, but teachers have been slow to discover and espouse these aids: Computers are still new and expensive; the old adage about old dogs and new tricks contains at least some truth; and human nature fears changing anything that already seems to work, at least a little. The Teacher Education Computer Laboratory is designed and equipped for the purpose of overcoming these problems. By allowing opportunities to learn and test new technologies in a laboratory setting, we hope to enhance the effectiveness of the teaching-learning enterprise in schools and to alleviate the fears inspired by the technology.

USING TECHNOLOGY TO FACILITATE SCIENCE INSTRUCTION IN ELEMENTARY SCHOOLS: BUILDING TEACHER LEADERSHIP AND INSTRUCTIONAL SKILLS

Nancy Romance*, Michael R. Vitale*

ABSTRACT

Described is the design, implementation, and preliminary findings of a cooperative university-public school training program to develop a cadre of elementary teachers able to contribute leadership by advocating improved quality of science instruction in elementary schools through various forms of technology and other means. In the project, selected elementary teachers enrolled in a 90 hour training program consisting of the following elements: (a) mastery of the Systems Impact Videodisk Core Concepts in Earth Science and Chemistry as a benchmark knowledge base, (b) mastery of model science-teaching strategies for enhancing student science concept understanding (e.g., direct instruction concept teaching procedures, "hands-on" experiments, PROLOG-based logic programming, simple expert systems development), (c) mastery of the enabling microcomputer software for lesson materials production (e.g., MS Windows applications), and (d) demonstrated professional leadership strategies for science advocacy. Also summarized are the results of complementary supporting research with elementary preservice teachers.

INTRODUCTION

The national literature has repeatedly targeted key requirements necessary for systematically improving the quality of science instruction in elementary schools, including (a) expanding the science knowledge of teachers, (b) building comprehensive teaching models for elementary science instruction that incorporates both advanced concept teaching practices and supporting "hands-on" activities; (c) increasing the utilization of technology and computer learning to enhance the quality of science teaching, and (d) identifying effective models for developing strong leadership roles for teachers advocating improved science instruction. This paper overviews a longitudinal effort to develop the capability to address the above needs within a cooperative university-public school inservice training format focusing upon science instruction at the upper elementary levels (i.e., grades 4-6). Additionally, other parallel research with elementary preservice teachers and with upper elementary students is also summarized in context of ultimately improving classroom science teaching practices.

INSERVICE PROGRAM OBJECTIVES

The inservice program reflects three propositions bearing upon the development of the capability for improving science instruction: (a) inservice training is a necessary vehicle for change, (b) advancements in instructional theory offer significant methodological improvements for teaching science concepts, and (c) advanced technologies exist to facilitate the delivery of both inservice programs to teachers and classroom science instruction to students.

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Specific objectives for the inservice participants reflecting the above propositions are as follows:

- mastery of the Systems Impact Videodisk Core Concepts in Earth Science or Chemistry as a form of benchmark science knowledge base,
- mastery of model science lesson teaching strategies incorporating student activities for enhancing science understanding, including concept teaching procedures, "hands-on" experiments, PROLOG-based logic programming, and simple expert systems production;
- mastery of enabling microcomputer software for lesson materials production, PROLOG programming, simple expert systems development); and
- demonstrated mastery of professional leadership strategies for science advocacy.

PROJECT RATIONAL: TEACHING FOUNDATIONS

The relevance of the objectives to improving instruction is well established in the research literature. More importantly, however, is their integration within the present project as a set of complementary teacher skills that may be used in an interdependent fashion. Of equal importance is the focus of the training objectives upon teaching applications using typical classroom science resources, including regular science basal textbooks, common laboratory materials, and readily available electronic hardware and software.

A number of recent research findings bear upon the present project design. First, both science methods research and applied educational technology theory have identified important factors for improving the effectiveness of science teaching. Second, recent research in complex learning and comprehension has provided evidence for the importance of science-content knowledge by teachers in solving instructional problems. And, third, related findings have shown that learner-constructed organizational guides, outline grids, and adjunct visual representations all facilitated science instruction.

The implications of the preceding research in science teaching can be viewed alternately from the standpoint of student learning in public schools or teacher learning of science concepts and methods. In both cases, improving the quality of science instruction involves combining expanded science knowledge, concept teaching pedagogy, and classroom procedures that facilitate science process skills through the integration of hands-on science activities with technology-based software environments focusing upon knowledge construction and application. Further, the major vehicle for implementing such changes in elementary schools must be new forms of skills-oriented and technology-based inservice training programs for elementary science teachers that represent a significant departure from present teacher training practices.

PROJECT RATIONAL: TECHNOLOGY FOUNDATIONS

A number of promising approaches reflecting advanced developments in technology and science concept teaching provide a strong foundation for the present project. One that addresses the problem of enhancing teachers' knowledge in science is the utilization of a specific videodisk technology designed to teach core science concepts using direct instruction principles. These videodisk materials in earth science and chemistry produced by Systems Impact are uniquely suited as an instructional tool in that a structured presentation of facts and rules (guiding basic physical science principles) are used to convey core concepts into visual displays which serve as "super outlines" for inservice teachers to organize and remember science information and concept relationships. Although data for the present inservice teachers are not complete, other work with preservice teachers has shown the videodisk materials to be highly effective science teaching tools.

The relevance of PROLOG, an artificial intelligence programming language, to the problem of improving science instruction is best understood by considering PROLOG programs as knowledge representation models that function as a form of theory construction. Research has pointed out the value of meaningful 'theory-building' activities in science instruction for novices having minimal domain-specific knowledge as a strategy for simulating the process of scientific knowledge acquisition. Because PROLOG is designed for symbol manipulation rather than numeric computation and emphasizes declarative program design, PROLOG easily supports the interplay of information structures and the application of logical rules within simple deductive systems. One simple application of PROLOG would be to build a rule-based animal classification system and query the system regarding it's content. Informal research studies of school implementation of PROLOG in European elementary schools describe a similar implementation model in which PROLOG logic programming applications taught to students as young as age 10 are embedded within school content tasks.

Expert system shells are software environments designed to support capturing knowledge in the form of "if-then" production rules and then guiding individuals through an objective problem-solving process using the knowledge-based rule system. Analogous to using a word processor to construct a document, building a simple expert system involves a mix of structured knowledge and identification of decision rules operable within the application of a knowledge domain, followed by editing of the system as it evolves. One simple application of an expert system shell in elementary science instruction is for students to use weather principles to construct a simple weather predictor that would assist students with the interpretation of newspaper weather maps.

Considered together, the videodisk core concepts material, PROLOG, and expert system shells provide a unique technology environment through which inservice teachers can gain increased science understanding by constructing models to explore and apply abstract knowledge and concept relationships. Combined with improved skills for teaching science concepts and conducting hands-on science activities, these technology approaches also provide a strong foundation for improving science instruction in elementary schools. Finally, enabling skills for using document production software to produce lesson materials and for displaying leadership for science advocacy provide the means for teachers to influence both classroom instruction and school policy.

IMPLEMENTATION DESIGN

The inservice program participants consist of 15 experienced elementary school teachers having responsibility for teaching science on a regular basis. The 90 hour program follows a multitrack design in which participants experience the videodisk materials during each session, complemented by hands-on activities and model lesson design procedures. Coordinated with the preceding topics will be parallel training on Expert Systems, PROLOG, and document production software. As the program evolves, participants will gain knowledge regarding curriculum issues bearing upon science instruction policy and learn leadership strategies for advocating improved science instruction.

Specific interactions among training components include the following:

Videodisk Technology for Science Knowledge. Participants will complete videodisk instructional materials stressing core science concepts in Earth Science and in Chemistry. In turn, the core concepts mastered will serve as a content focal point for subsequent model lesson design.

Model Science Lesson Development. Participants will learn how to design classroom science lessons based upon science textbooks that integrate content knowledge with science process skills based upon current concept teaching methodology. Included in the development model are specific procedures for concept introduction and concept expansion through hands-on activities. Within this context, participants will learn to use document production software to support lesson materials development.

Technology-based Knowledge Exploration Software Environments. Participants will learn how to design classroom learning tasks using the PROLOG programing language focusing upon clarification of core science concepts and relationships and using simple expert systems software focusing upon the application of core science concepts and relationships.

Leadership in Elementary Science Advocacy. Participants will gain knowledge of recent curriculum issues affecting school instructional policy. This knowledge, along with the focus of the inservice program, will be incorporated into leadership strategies advocating improved science instruction.

PROJECT RESULTS AND OTHER SUPPORTING RESEARCH

Preliminary results available at the time of the conference will be presented along with parallel findings with preservice teachers.

A COMPARISON OF MICROSOFT WORKS COMPUTER-BASED TRAINING MATERIALS WITH TRADITIONAL INSTRUCTION: A PROJECT REPORT

N.T. Bell

ABSTRACT

Two methods of teaching concepts related to instructional applications of Microsoft *Works* were compared in the university setting . The first method centered on the use of the computer-based training materials provided with Microsoft *Works* while the second method used traditional teaching with overhead transparencies and student worksheets. In the first method the students were provided with the Microsoft *Works* CBT diskettes and given a schedule guiding them through approximately eleven hours of instruction. In the second method, the instructor presented similar concepts using more traditional instructional methods and materials. The criterion for both methods was twofold: first the students were asked to develop specified products using Microsoft *Works*. Included in the products were the production of tests, quizzes, and student worksheets using the word processing application; the production of a gradebook using the spreadsheets and charts application; the development of student files using the databases and reports application; and downloading and uploading information to a bulletin board using the communications application. Secondly, in addition to the evaluation of these product-oriented activities, learning for students in both groups was assessed using a final examination in the multiple-choice format. In this presentation there will be a description of the findings of the study as well as a display of the instructional materials used in the traditional setting. In addition, there will be a display of the student-generated products.

Michigan State University

USING VIDEO TO ENHANCE THE PROCESS OF CURRICULUM INTEGRATION OF COMPUTER COURSEWARE: A PROJECT REPORT

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Ken Poverude[^], Benita Toler[^]

ABSTRACT

Recent concern regarding computer applications in the classroom has focused on the process of curriculum integration, that is implementing computers as tools to enhance learning. Some recent research has indicated that though there are many computers in the classrooms in the school in the United States, half of the teachers have never used these computers in the instructional program, and of the half that have reported use, only a minor portion of them reported using the computers with any regularity. Many efforts have been undertaken to encourage teachers to integrate computers in their regular instructional program. One of the most effective ways has been to send into the classroom of a non-using teacher a teacher who has been successful in curriculum integration and ask that teacher to demonstrate how the computers can be used. In the Wethersfield Project video tapes were developed to substitute for that experienced teacher. Non-using teachers then could study the video tape, much as they would study the presentation of the live teacher, and then proceed with curriculum integration in their own classroom.

INTRODUCTION

For the past decade efforts have been directed at integrating computer courseware into the existing school curriculum. Initial efforts focused on the task of selecting the software to be integrated, and a variety of evaluation methods were implemented to ensure that only the best software was selected for such integration. As helpful as this evaluation process has been, it appears that providing listings of the best courseware, and even accompanying the lists with the results of detailed evaluations, has not been sufficient to stimulate the use of courseware by a significant number of teachers. From data reported recently in the study conducted by the Office of Technology Assessment of the U.S. Congress, it can be concluded that there are many computers already in the schools which are not being used in the instructional setting. Recent efforts regarding curriculum integration have indicated that one of the more successful methods has been to send into the classroom of the non-using teacher a teacher experienced in the use of computer-based courseware and have that teacher demonstrate the process of integrating the courseware into the curriculum. However, the typical school system would most likely find it very difficult to be able to locate such an experienced teacher, knowledgeable across grade levels and subject matter areas. Consequently, the focus of this project was to develop video tapes as a substitute for that experienced teacher and thus make available the information in an inexpensive and efficient manner.

EVALUATION OF COMPUTER COURSEWARE

In the past, in order to support the process of courseware acquisition, reviews of such courseware were conducted and summaries of the reviews published. Essentially, the courseware which was initially included in these reviews was courseware which had been designed for use in the mode which became known as Computer-Based Instruction (CBI) or Computer-Assisted Instruction (CAI). In the earliest days of the implementation of microcomputers in the classroom setting, teachers and other curriculum specialists requested

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[^] Department of Defense Dependents School, Atlantic Region rather detailed information concerning the courseware, such information they felt was crucial for curriculum integration. In order to provide such information, processes of courseware review were established. Within local school districts, regional service centers, state departments of education, and national educational agencies, efforts were made to create standardized reviewing techniques, and then to use such techniques in evaluating courseware and reporting its predicted effectiveness. Regularly these reports have been published in computer journals devoted to the use of computers in the classroom. In addition, these reports were often gathered and published as collections of evaluations, sometimes grouped according to subject matter and grade level. In some cases the courseware publishers obtained such reviews and provided them to individuals who were in the position to purchase significant quantities of their courseware. In all cases the goal was to produce sets of information that would be useful in the selection and integration of computer courseware as part of the regular classroom activities.

INITIAL CURRICULUM INTEGRATION EFFORTS

It would appear that the initials goals of the courseware evaluation process have been reached. There are numerous sources to which purchasers of courseware can refer in order to be able to select the highest quality programs. However, recently there has been a growing concern that such reviews are not sufficient for those teachers lacking computer experience to be able to integrate such programs into the curriculum. It became apparent that additional efforts were needed to provide the typical classroom teacher with the experiences necessary to be able to use the microcomputer with any regularity in the classroom. One method which has apparently been quite successful has centered on locating an experienced teacher, one who has been successful in integrating courseware in the classroom, and releasing that teacher to spend time in the classrooms of those teachers desiring to learn how to accomplish such integration. In those districts where such efforts have been undertaken, it appears that the non-using teachers can very quickly be shown how to use the courseware and will, in fact, continue to use the courseware with little additional assistance.

Several problems become evident in this process of integration. First, for many districts it may be almost impossible to find a teacher who has had successful experience with the curriculum integration process. Second, assuming such a teacher can be identified, the range of experience across grade levels and subject matter areas of such a teacher would apt to be quite limited. Third, such a teacher would have to be provided with released time, and since such a process is labor intensive, the costs would be too high for such a project to be continued over an extended length of time. Consequently, though such an integration plan may appear to promise success, the negative factors may outweigh the positive effects, and most districts would be unable to undertake such a program.

USING VIDEO TAPES TO ENHANCE CURRICULUM INTEGRATION

It appears that the courseware evaluations, even those done by the most sophisticated evaluators, are not sufficient to provide the experiences necessary to provide the non-using teachers the skills required to integrate the courseware in their regular teaching activities. Further, it appears that for most schools, if it were possible to locate the teacher experienced in curriculum integration across grade levels and subject matter areas, the cost of the released time would most likely prohibit such a project. Consequently an alternative to these methods which is affordable needed to be devised, such an alternative being in the form of specially-designed video tapes.

THE WETHERSFIELD PROJECT

A project was therefore developed which would use video tape to provide the non-using teachers the experiences which were made available by the released-time expert. The general goals of this project were to locate experienced teachers, have them identify the courseware which they had found to be most useful in their classrooms, and videotape them while using the courseware with students. The outcome of the Wethersfield Project was to be a set of video tapes displaying methods of curriculum integration with a variety of courseware extending across subject matter areas and grade levels.

During a summer institute, held in Wethersfield, England, in June 1988, four experienced teachers, one computer coordinator, and a researcher served as experimenters in committing to video tape examples of curriculum integration. The opportunity for this first effort came about as part of the curriculum integration emphasis of the summer institute. Teachers from the Atlantic Region of DoDDS had been given the opportunity to apply for the institute, twenty four of whom were selected. There were two major emphases of the institute: the use of AppleWorks in the Classroom Setting, and the Evaluation of Computer Courseware. As part of the evaluation portion of the institute, teachers were given the opportunity to volunteer for the video project and four teachers with a range of subject matter expertise and grade level were selected.

PREPARATIONS FOR THE TAPING SESSIONS

Each of the four teachers was given the opportunity to identify the computer courseware which they were to use in the project. As part of the institute there had been made available approximately 125 courseware packages, and it was from this set that the teachers selected the material. With the courseware identified, each teacher then developed a lesson plan describing the integration of the courseware in the lesson to be taught. In addition, a request for students was made to the local DoDDS principal, and seven students were made available. Since the summer break for the students had started the week prior to the commencement of the institute, student volunteers were made available for the project. Two students from the fourth and fifth grades and three from the sixth grade became part of the project.

A room was prepared with the required equipment which included three Apple IIGS computers, a student work area separate from the computers, and the video equipment consisting of two camcorders and tripods. The room was arranged so that the teachers could work with the students in a small group around the computer, the students could work independently at the two additional computers, and the students could work independently with paper-and-pencil tasks at a table seating four students. Three computers were used because DoDDS already has some classrooms designated as experimentals classrooms and outfitted with three computers.

TAPING OF THE TEACHING SESSIONS

The teachers worked with the students as they would have worked in their own classrooms. The lesson was introduced, the transition made to the tasks related to the lesson, and the lesson taught. As part of each of the presentations, the teachers demonstrated the use of the computer and the courseware selected. To record the classroom activities, two camcorders were used, with one focused on the entire group, and the other focused on the computer station. Both camcorders ran continuously throughout the sessions as the editing was to be conducted at a future time.

TAPING OF THE STUDENT DEBRIEFING

Immediately following the completion of the lesson and the associated individual work done at the computers and at the paper-and-pencil work station, the students were called together to meet with the teacher and a debriefing was conducted. In this debriefing the teacher sought to have the students explain their view of the use of the computer and the courseware. Questions were asked concerning how they liked the lesson, what they felt they had learned from the lesson, what things they liked best from the lesson, and how they felt about the use of the computer for that particular lesson. A camcorder was used to collect the information from this debriefing.

TAPING OF THE TEACHER DEBRIEFING

Following the taping of the student debriefing, a similar procedure was followed in the debriefing of the teachers. The DoDDS computer consultant conducted each of the teacher debriefings and similar questions were asked of each teacher. The questions focused on the reasons the courseware was selected, the preparation required to implement the courseware, the ways in which the courseware assisted the teachers in reaching the lesson objectives, the strengths and weaknesses of the courseware, and other questions related to the kinds of preparation needed to integrate the courseware in the lesson. Special emphasis was placed on the management techniques required to be able to implement the courseware with from one to three computers in the classroom setting. Again a camcorder was used to collect the information from these debriefings.

TAPE EDITING

The next task was the editing of all the data recorded on the camcorders into a usable video tape. As previously indicated, the purpose of this project was the development of a series of tape recorded illustrations which could be provided to non-using teachers for the purpose of showing them how to integrate the computer into their regular lesson plans. The editing task then had as its main function the reduction of data to a set which would most clearly depict such computer integration. Included in the editing process was the selection of the most appropriate footage, the addition of titles, subtitles, and voice-over to enhance the tapes, and the merging of the four examples into a single tape. Further, an introduction to the series was written and recorded. This entire process was supervised by a DoDDS technical expert who provided much more than the technical expertise, in that he was able to consult on changes needed to cause the resulting tapes to be far more effective in communicating the process of curriculum integration. Thus, on a single video tape there was captured a series of examples of how the computer and associated courseware could successfully be integrated into the daily regular plans of the representative teachers.

SUMMARY

This project had as its main objective the development of video tapes which could serve as a means of encouraging teachers who had not been trained concerning curriculum integration of computers. The video tapes were designed to provide not only an introduction to the ways in which specific pieces of courseware could be used in the classroom, but actually to show accomplished teachers, using the courseware, working with children in a classroom setting. In addition, it was felt that it was important to capture the views of the students concerning the use of the courseware, and also the views of the teacher concerning the selection, preparation and use of the specific courseware. Throughout the design of this project an underlying concern was to show that even though the number of computers in the classroom was very limited, the teachers could make efficient use of the courseware. The result of this first attempt are video tapes which depict the actual use in a classroom setting of specific pieces of courseware. It is expected that teachers viewing these video tapes will be able to use these programs as shown on the video tape, and in addition may very well create new approaches to the uses of such computer courseware. Then these new approaches could also be video taped and distributed throughout the system, thus causing the outreach of this project to be continually expanding.

CASTLES & CREATURES: A BILINGUAL IVD PROGRAM PRODUCED FOR LESS THAN $50.00

A. E. Barron*, Z. M. Boulware#, S. C. Varnadoe•.

ABSTRACT

This paper addresses the design and development of an interactive video lesson created at the University of Central Florida, Orlando, Florida, for students in grades seven and eight in Central Florida schools. The program consists of a $49.00 repurposed videodisc, authored with HyperCard™. The basic premise is that interactive videodisc is possible and effective without a large production budget.

INTRODUCTION

Interactive video combines the interactivity and flexibility of a computer with the audio and visual capabilities of video. This combination is credited with significantly faster learning and improved retention (ref 1). Martin Marietta and other large corporations, as well as the U. S. military, are all implementing interactive videodisc into their training programs. However recent reports indicate that the technology is not penetrating K-12 schools, partially because of production costs . Producing and mastering one videodisc can easily cost $50,000-$150,000 per videodisc side (ref 2), well beyond the scope of public schools which have an average annual budget of $1400 for software (ref 3). A viable alternative to the production expense is to repurpose (ref 4) one of the many existing videodiscs that are commercially available (ref 5).

DESIGN

The videodisc selected for this application is entitled *Salamandre: Châteaux of the Loire*. It incorporates motion sequences, computer animations, over 750 still frames, and text to provide audio and visual visits to eighteen of the châteaux in the French Loire Valley. The disc was purchased "blindly" from the Voyager Company in California (ref 6) with assurances that the money would be refunded if we were not satisfied with the quality.

Because the content of a repurposed disc is predetermined, the first, and by far most tedious, step is to log the disc. This is a time-consuming task that consists of recording the beginning and ending frame numbers of motion sequences, recording individual numbers of still frames, and "rewinding" endless times to write out the script for each audio segment. After the log is created, it should be categorized by subject for easy reference. If sound, either musical or vocal, accompanies the video, the numbers should correspond with beginnings and endings which are esthetically pleasing. (See figure 1.)

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#Tuskawilla Middle School, Oviedo, Florida, 32765
•Analysis and Technology, Orlando, Florida, 32803
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HyperCard is a trademark of Apple Computer, Inc.

Frame	Numbers	Description
MOTION SEQUENCES		
121 -	22754	Flybys of the châteaux with sound, music
22755 -	48700	Description of exteriors/interiors with narration
48701 -	51630	Animation of the insignias of French royalty
STILL FRAMES OF SALAMANDERS		
	51813	Salamander on exterior column
	52060	Salamander, carved in block of stone
	52666	Salamander, painting on tile

Figure 1. Example log of *Salamandre: Châteaux of the Loire* videodisc

After the content of the disc had been outlined, cataloged and analyzed, the design phase was begun. The intent was to design a lesson for seventh and eighth grade students in social studies that would focus on the artwork of the French châteaux in the Renaissance period. A "treasure hunt" gaming approach was selected for the instructional format to motivate the students. The students embark on a journey of the seven continents looking for an art treasure "hidden" in France. The journey includes flybys of several châteaux, computer animations of château history, and still frames of art treasure.

AUTHORING

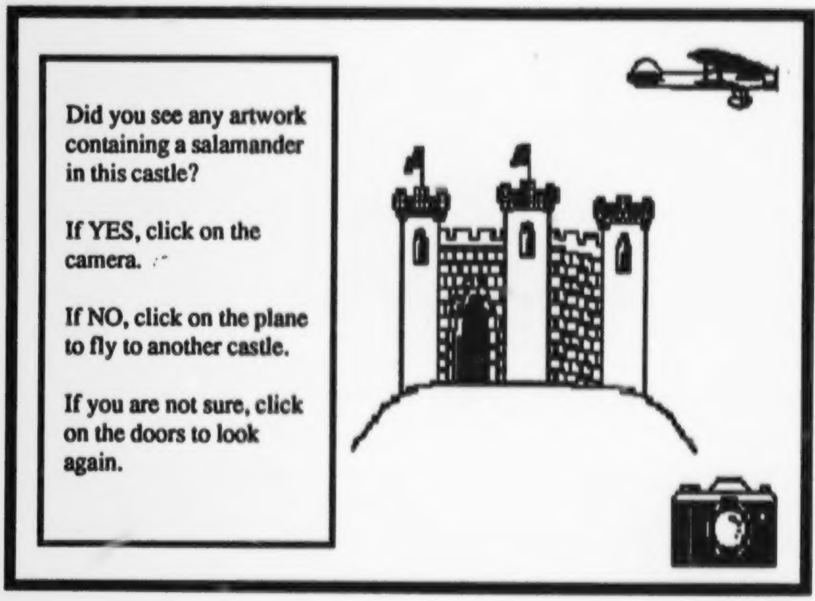
In order to expand on the content of the videodisc, transitional and instructional materials were added on the computer. HyperCard was chosen as the authoring tool because of the ease of authoring and incorporating graphics.

The program begins by showing the student a still frame of a salamander and several art pieces featuring salamanders. The student then begins to explore the seven continents looking for the artwork. Optional branches are available on the computer if the student chooses to learn about animals, etc., on the continents. Through a combination of computer and learner controls, and hints on the whereabouts of the treasure, the student eventually chooses Europe and then begins to explore the European countries. The majority of the video segments begin when the student reaches France and can "fly" to several châteaux and search for the art treasure.

The course, entitled *Castles & Creatures*, consists of a total of 54 screens (cards). As indicated in figure 2, the cards are graphically intense, with most of the graphics imported from various clip art programs. Supplemental graphics were created using the HyperCard graphic tools, or by using a scanner. Audio feedback was incorporated using HyperCard built-in sounds.

Very little programming was required for the lesson. The basic commands used were *video*, *answer*, *play*, and *visual effect*. Figure 2 shows examples of two different programming scripts: a button which activates the video and a card script that provides feedback when a student "clicks" on an incorrect area. The course is delivered on a Macintosh™ computer with at least one megabyte RAM. This configuration requires the use of two monitors which involves coordination of both visuals for smooth transitions between sequences.

Macintosh is a trademark of Apple Computer, Inc.



Did you see any artwork containing a salamander in this castle?

If YES, click on the camera.

If NO, click on the plane to fly to another castle.

If you are not sure, click on the doors to look again.

Script of airplane button:

```
  on mouseUp
    video search, 9500
    wait 1
    video play, till, 10530
    wait 30 seconds
    go to card id 7835
  end mouseUp
```

Feedback for a click in an incorrect area:

```
  on mouseUp
     answer "Click on the
     plane, entrance, or
     camera." with "OK"
  end mouseUp
```

Figure 3. Example of card and scripts from *Castles & Creatures*

IMPLEMENTATION

The program was tested in several Central Florida schools. The student evaluations were extremely favorable. The children were captivated by the program and had little or no trouble operating the mouse to make their selections. Observations from the classroom teachers revealed that most of the students chose to branch out for more information, even when the program did not require it. Student evaluations reflected the current fascination with video games. One student wished to see the salamander conquer the castle, and many requested a more exciting reward for finding the piece of art.

EXTENSIONS

The disc contains two audio tracks, one in English and one in French. After the initial success of the pilot test in social studies classes, it was decided to translate the stacks into French and switch audio tracks, thus creating a lesson for students in French classes. The French stacks were easily created by copying the stacks and replacing the text portions. The resulting lesson is appropriate for third or fourth year French classes. An interesting note is that if this course were to be implemented with students in France, the section on the continents would have to be revised. In France they learn that there are 5 continents, not 7. (North and South America are considered one, and Antarctica is not a continent.)

LESSONS LEARNED

Creating these lessons proved to be an interesting and insightful experience. The following hints are offered to help make the procedure easier:

- Learn the Macintosh first; do not attempt a HyperCard application as your first project.
- Learn the HyperCard shortcuts. As with most Macintosh programs, a keystroke or two can be much more efficient than the pull-down menus.
- Log the video segment accurately and thoroughly (or buy a disc that has previously been logged).
- Make a printout and catalog all of the available clip art. This can be done from the documentation that accompanies the program or from printouts of the art work.
- Use good design techniques. Try not to overuse all of HyperCard's special effects.

CONCLUSION

The resulting program is a good instructional lesson, created with very little programming, for a production cost of $49.00. It teaches the continents and several countries of Europe, and it provides an opportunity for students to see artwork in natural settings. Out of the available 750 stills on the disc and the 25 minutes of motion, the program used only 22 stills and 6 minutes of motion. Plans are underway to use the same disc to produce additional programs, perhaps for a higher grade level, that focus on architecture, French history, or culture.

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Castles & Creatures is a program copyrighted by the authors and was developed as an independent study project at the University of Central Florida.

INTERACTIVE VIDEO IN COMPUTER TRAINING

A Elsayed and R Wilson

ABSTRACT

Interactive Video (IV) is a very powerful medium for training applications. Its real potential, however, can be fully realised in situations where real life equipment can be operated under the full control of the IV delivery station. In this case hands on experience can be provided as part of the instructional programme. There are several possibilities in which such an arrangement can be achieved. Two specific cases are now being considered at Leeds Polytechnic. The first is concerned with the design of instructional IV material for practical experimental work that forms part of the education and training of electronic and communications engineers. The second case, which is the subject of this paper, directly addresses the computer training problem. The technique suggested here is based on a world-wide patent filed at the British Patent Office (No 8800540). In this paper the authors present and discuss the interactive video implementation of this technique by which a microcomputer, running application software, can be fully controlled by the IV delivery station. It will be shown that in this mode of operation it is possible to provide a very powerful stand-alone interactive medium for computer training with full hands-on capability.

INTRODUCTION

Interactive Video has emerged as a very powerful tool in instructional technology or, more generally, information assimilation. This is because, simply, it combined the effective media of the moving picture with the powerful tool of computer processing. This combination, for the first time, offered a truly multimedia information environment. Instructional technologists, information technologists and marketing specialists jumped at this new technology in an attempt to realize its potential in education, training, cataloging and marketing. In the education and training area technologists were taken by the possibility of being able to develop in the learner an awareness, about a specific subject matter, based on recordings of real life events. This meant that it was finally possible to provide the learner with a manageable learning experience that is second only to a real life encounter. This feature in the IV technology fascinated training and educational professionals who started immediately in a trail of pursuit for the realization of this potential in IV.

The real potential of IV, however, lies in the ability to provide the learner with a guided and controlled hands on experience which can be supported by an integrated instructional presentation. This can develop in the learner a WORKING skill that was previously possible only by using a human instructor. Of course, persistent learners can develop such a skill in some areas by a painstaking effort spent with manuals and self-teaching books. This type of learner, however, represents a very small percentage of the average learning population with whom we are mostly concerned. Moreover, the rate of information assimilation in such self teaching situations is much lower than that of instructor led cases. In an age with an unprecedented rate of technological

Leeds Polytechnic UK

change we find that there is an ever increasing demand for new instructional means that lifts the rate of information assimilation.

At Leeds Polytechnic two application areas are being investigated. The first is concerned with the development of surrogate electronic lab. experiments to support an IV instructional package that is being developed for the Independent Television companies. This work is reviewed in another paper in these proceedings. The surrogate lab. technique itself will be presented and discussed in separate publication.

The other area in which IV can be used in a 'HANDS ON' configuration will require its own configuration of hardware, software, development and delivery techniques.

THE DELIVERY SYSTEM

The main functions of a computer training system for application software, that is capable of providing a guided and controlled 'HANDS ON' experience are as follows:

- to relieve the main computer that runs the application software from any other functions unless such functions would not intervene with the normal operation of the target application software;
- to control the main computer by emulating keyboard inputs that such a computer would expect from a user for either operating commands or application software instructions;
- to deliver audiovisual instructions that explains the performance and handling of the target application software. The visual information will be either video illustrations or pointing action to highlight specific screen displays that are produced by the application software;
- to prompt the learner for entering specific commands or data strings by himself through the keyboard;
- to verify the keyboard inputs entered by the learner before passing them through to the computer system.

The above five points constitute the main requirements from an instructional system that is capable of performing a stand alone computer training function including the supervision of a 'HANDS ON' exercise.

The system shown in figure 1 is a possible configuration that can satisfy the above requirements. This implementation is particularly suited to the use of Interactive Video technology. In addition to investigating the operational aspects of this system, concurrent work is progressing on an alternative arrangement that uses other types of storage media. This work will be reported in future papers.

In the configuration shown in figure 1 the central element is a microprocessor based board that controls the whole system. The control software will be downloaded onto the RAM of this board through a serial, parallel or bus connection to the application computer from its disc drive. This will relieve the requirement of a special storage device for the loading of this software.

The microprocessor board will have the following other connections:

- an RS232 or system bus connection for controlling the Interactive Video Adaptor (IVA) board;
- an RS232 connection for controlling the Laser Disc Player (LDP);
- an output keyboard connection for sending emulated keyboard signals to the application computer;
- an input keyboard connection for receiving keyboard inputs that are entered by the learner.

The IVA board can be as simple as a GENLOCK device or it can be as sophisticated as the MIC IVA board of Videologic. The sophistication of the MIC system, however, is not necessary in such an application and the simplicity of a mere GENLOCK would be much more desirable. This will simplify the control action required from the main control board.

The emulated keyboard input sent to the application computer from the main control board will be one of three types:

(a) a direct input generated form the control programme;

(b) a verified input that originated from the keyboard by the learner. This category of inputs comprises mainly operating system commands or application software instructions;

(c) a un-verified input that originates from the keyboard by the learner. This category of inputs comprises data items like text strings or numerals.

The above described system is still under development at Leeds Polytechnic. A Z-80 microprocessor will be used as the central processing unit on the board. A couple of possible board designs are currently being evaluated for the prototype production. Unfortunately, there are no actual results to report at this stage. Such results will, however, be reported in the very near future.

THE DEVELOPMENT SYSTEM

The effectiveness of the above described delivery system makes it very attractive in view of its construction simplicity. The development system, however, that is responsible mainly for generating the control software is quite involved. Although it is possible to generate material for the above delivery system by crude methods such an approach is very tedious and, therefore, is unsuitable for commercial exploitation. Work is now in progress on some effective development techniques to be used in conjunction with the above delivery configuration.

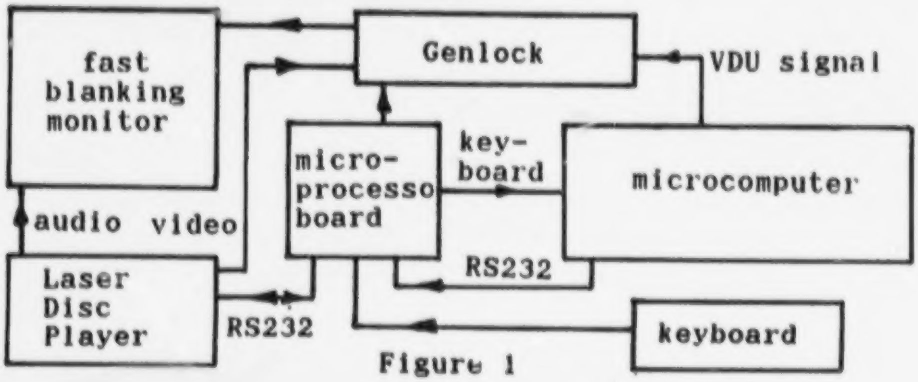

Figure 1

Ask the Workers . . .: IMPROVING CAREER CHOICE WITH INTERACTIVE VIDEODISC

John G. Hedberg*

ABSTRACT

The state of Western Australia, realising the potential of the emerging technologies, supported a project to examine the use of interactive videodisc technology in schools. The writer was contracted to design and develop a system which would enable students to explore options and understand some of the parameters of career choice. The project was designed to focus upon the range of choices available at different educational levels and to encourage students to consider options based upon decisions about staying on at school and their interests, rather than their limited experience. The range of career choices revolved around those traditionally termed "vocational education" options rather than those which related to the professions. Most significant about this project were the two target audiences, the lower level high school student and the hearing impaired. The choice of the medium with overlay teletext enabled the hearing impaired, to view the options available to them with language support.

From the start the design of the *Ask the Workers...* project was to provide a new conceptual structure for introducing students to a range of jobs and some factors in planning for a career. Not everyone understood that to deal with the design parameters in the same way as they had undertaken other curriculum projects, was a pitfall that might produce materials which did not employ the inherent advantages of the videodisc medium. Even in the earliest discussions the project managers saw that an interactive videodisc allowed the generation of teaching materials which could present images and sound in a variety of flexible ways. These presentation strategies would also allow additional cues for a hearing impaired audience at minimal additional cost. In short, one set of instructional materials could be used for a variety of audiences and for several instructional purposes.

DESIGN TEAM BEGINNINGS

This project was like many other curriculum projects in that it relied upon the skills of a team of people, with skills in: production coordination, instructional design, career education content experts, video script writing, video production, educational computer software design, and the evaluation of new technologies. However, several important differences must be noted about this curriculum project; the time frame for the project was six months (rather short for a large group project); one person only (the production coordinator) worked on the project full time; and the career education area had some keen content specialists working within it, but there was no clearly defined curriculum, nor would any development cut across any entrenched curriculum materials or personal agendas.

Content expertise was easily located, but not all people were able to work in a creative project with fairly tight deadlines and complex mix of educational materials. The content team finally assembled critiqued the design briefs, evaluated the scripts, suggested alternatives to the teacher activities in the teacher's guide, pointed to current areas of debate in the processes of career choice, and worked within the constraints of the medium to define a structure on which could be hung the physical organization of the disc. Databases were used to coordinate the development of the picture store database on additional career opportunities, this information was then used to generate the cross-indexed listing that appeared in the teacher's guide and which provided a comprehensive picture collection on careers with captions for the hearing impaired.

Using the Macintosh to exchange information went beyond the capabilities of any other machine available at the time, and this speed of production enabled the project to be *fast-tracked*. The complete brief for the computer software was not totally developed before the final visual script nor with complete knowledge of the range of material which would form the pictorial database on careers. Even at the conclusion of the formal design team meetings, sections of the final materials were not fully specified in the way they might be incorporated into the finally released computer programs. This incomplete specification was intentional, it was always a belief that the teacher using the materials should have some contribution to the final design of the materials in their classroom implementation. Any technological delivery system can be controlled by the user, even if the control is as simple as turning off the power supply. With this package it was hoped as the teacher understood more about the technology that he or she might take some of the suggestions about the use of the materials and implement them in their own way.

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The interactive videodisc does allow a wealth of visual and aural input to be shown in a variety of ways, not the least is the potential to combine each presentation mode into a composite educational program. Single pictures might be shown to illustrate concepts with action sequences used more sparingly — this would obviate the need for long sections of the disc to be used for dramatised or moving sequences. The design of the disc needed to allow for different levels of technological sophistication in accessing the materials. If a teacher was interested in using only the videodisc player, then the materials had to work easily in the configuration. This level has been termed level I interaction by Iuppa (1984) and is the basic level requiring only the player. Teachers familiar with the use of any videotape player would be able to use the similar operations on the disc player.

At the more advanced level (Iuppa, Level III), the teacher was encouraged to use the interaction with computer control. At this level the materials formed a self-study kit for individual students. Apart from the fact that most students were more at ease with technology than their teachers, this individual interaction approached the personal decision-making processes which were considered key to effective career decisions.

While the disc might allow more sophisticated programming it does require an investment in the hardware and, when combined with a microcomputer, does require some effort in understanding the technology. Most importantly, the particular system chosen under the policy of computer purchases in the school system did constrain the final design. The authoring system chosen for the project allowed the presentation of information in a frame-oriented format but raised other problems about the ease with which keen teachers could create computer controlled materials.

CONCEPTUALISING THE TOPIC

In this project it was intended to test the effectiveness of the videodisc technology as a means of creating interest in the exploration of career options. Faced with the problem of career choice, many young students opt for the choice of jobs they know or follow the advice of parents and friends. To overcome the stereotype and create a sense of exploration, the *Ask the Workers...* project endeavoured to design a visual experience that was involving and challenging. Numerous attempts have been made to use the computer to select an individual profile and suggest a career to the enquirer, but many of these systems do not allow revision of choices and little information is provided other than a list of job titles. A wealth of materials about different careers is available, but many students do not use these resources, so the immediate design objective was not to duplicate this extensive material but rather to create a situation in which the student might try to explore a range of possibilities.

Comparisons with other computer-based career selection systems were researched to see how they had tackled the exploration approach to the career decision process. It seemed that many of the existing systems did not allow a flexible approach to searching amongst possible options. One of the choices that each person has to make is the time they will stay at school. Realising that this decision can limit the range of options can be the beginning of the search for a career path which might include more educational experiences. The final structure used some of the futuristic ideas of Borchard (1984) and suggested that a number of alternatives might be shown. This structure was elaborated in a number of other publications but the general concept appeared to be fairly widespread and thus provided the first simple conceptual structure. The article served the designers and content experts alike as a main focus from which to generate new ideas for the package content.

A matrix emerged as a way of conceptualising the link between educational level attained and the general career type. Figure 1 helped provide the focus for much of the subsequent discussion. The simple generation of the pictorial representation served to show the potential layout of the final disc and later on the computer programs. In designing the disc the team tried:

- to overcome stereotyped images of particular jobs.
- to emphasize the width of career choice available, and the importance of keeping options open (and perhaps the converse, the options closed by making choices).
- to emphasize the many jobs that one person could do.
- to stress that career paths are in constant change.
- to show a range of information sources as the students search for clues to their possible career options.

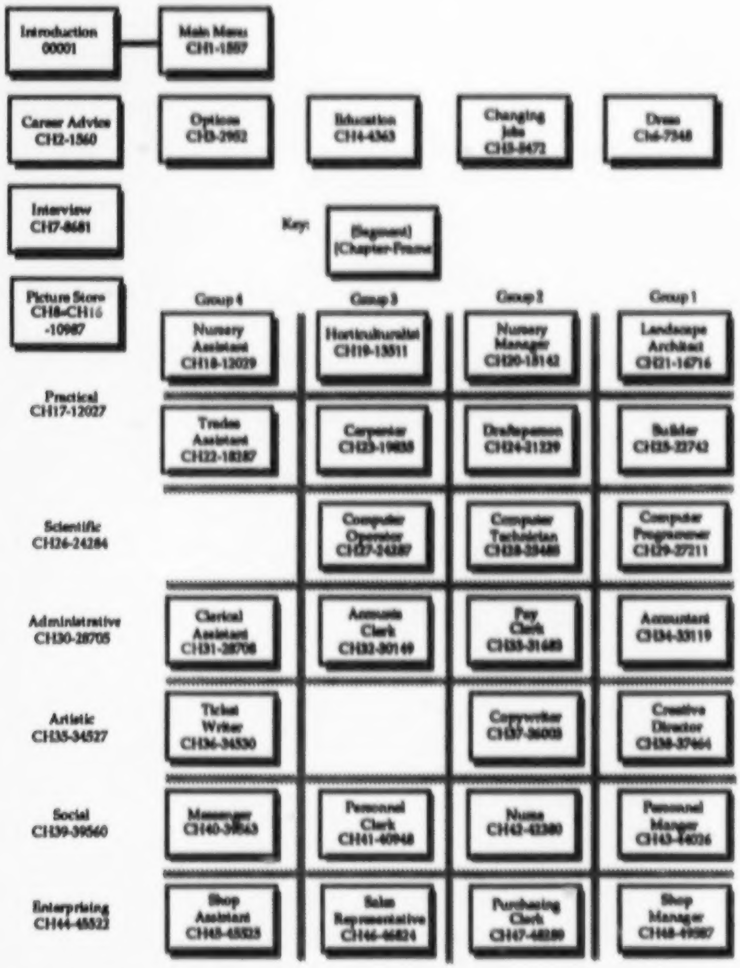
Introduction 00001
Main Menu CH1-1557
Career Advice CH2-1560
Options CH3-2952
Education CH4-4363
Changing Jobs CH5-5472
Drama CH6-7348
Interview CH7-8681
Key:
[Segment] [Chapter-Frame]
Picture Store CH8-CH16 -10987
Group 4
Group 3
Group 2
Group 1
Nursery Assistant CH18-12029
Horticulturalist CH19-13511
Nursery Manager CH20-15142
Landscape Architect CH21-16716
Practical CH17-12027
Trades Assistant CH22-18287
Carpenter CH23-19835
Draftsperson CH24-21329
Builder CH25-22742
Scientific CH26-24284
Computer Operator CH27-24287
Computer Technician CH28-25485
Computer Programmer CH29-27211
Administrative CH30-28705
Clerical Assistant CH31-28706
Accounts Clerk CH32-30149
Pay Clerk CH33-31685
Accountant CH34-33119
Artistic CH35-34527
Ticket Writer CH36-34530
Copywriter CH37-36003
Creative Director CH38-37464
Social CH39-39560
Messenger CH40-39563
Personnel Clerk CH41-40948
Nurse CH42-42380
Personnel Manager CH43-44026
Enterprising CH44-45522
Shop Assistant CH45-45525
Sales Representative CH46-46824
Purchasing Clerk CH47-48289
Shop Manager CH48-49587

Figure 1: Matrix structure of the Ask the Workers... videodisc

Each rectangle on Figure 1 represents a segment of video on the videodisc. For example, the interview is a segment called 'Twenty Questions', a series of questions asked directly to camera covering the range of questions which might be asked at an interview. At level I interaction, the questions were replayed to a class, with the teacher stopping and starting the player at appropriate points and using the material as the stimulus for classroom discussion about interview techniques and generating appropriate responses.

The lower half of the diagram represents the career example matrix. Across the top, the groups refer to education qualifications required for a particular career, as follows:

Group 1—requires a degree or diploma, or be skilled and experienced in the area.
Group 2—assumes a completed secondary schooling or some work skills obtained at a technical college.
Group 3—does not require completion of secondary school, but part-time study and on-the-job training may be required.
Group 4—requires no specific standard of education.

The categories down the left-hand side refer to personality types and career categories following the Holland model. Each rectangle in the matrix represents a short segment of video on the videodisc, with an average length of 60 seconds. The segments would concentrate on the careers towards the Group 4 side of the matrix of careers, because of the nature of the audience intended for the materials.

Each occupational environment has been structured in a progression of vignettes in that it attempts to focus on the progress of the person as they become more skilled or more senior in their career path. The same actor plays all segments within a particular stream. Some alternatives can be presented from the store of still pictures available on the disc. These might be realistic alternatives which remain within the same career path, e.g. in the retail sector they might become an advertising specialist or a store manager or even go into the data processing division after the student undertakes an evening course in "programming".

The picture store is a selection of over 1000 individual pictures depicting a wide variety of occupations. It was structured along the lines of the six broad personality types and it can be used to illustrate other related jobs which might be undertaken by people of the same personality orientation.

COMPUTER PROGRAMS

At this stage, it seems there are three programs for Level III interaction:

1. **The Searches**. A program which identifies student's personality styles according to a series of measures. This program controls the presentation to suit the individual user, and encourages the user to change some of her or his answers to see the consequences of such changes.

2. **Twenty Questions**. A second program will turn the interview questions sequence into a simulation of a real interview, with answers required to be provided by the user. On the basis of the answers provided, a typed application for a job is printed.

3. **A Subtitle program** which allows teachers to subtitle sections of this or any videodisc.

Overall, the computer programs were designed to allow students to choose and to explore options. Within the constraints of the authoring software, there was an attempt to reduce the reading and improve the amount the student had to contribute to provide a final visual reward. The structure for a student who was narrowly focussed encouraged some rethinking otherwise no further video sequences would be shown. Certainly, we were encouraged when the interest profiles were pilot-tested with the similarity of the responses they produced under the two different means of generating them. In fact its consistency would indicate that there might even be the basis for a effective and simple career selection test. It was hoped that if, the systems for running the computer–controlled videodisc system were sufficiently simple, then the more enthusiastic teachers might be able to develop their own program ideas.

EVALUATION

The materials were field tested at ten sites. These included high schools with and without special classes for the hearing impaired. In the evaluation Professor Michael Scriven (1988) claimed:

> For the hearing impaired students, despite several reservations which follow, the medium is, in general, ideal. It is a new and exciting visual way of presenting information that is usually presented in more traditional ways and with much less impact. The students who have severe hearing

> impairment often have a lower reading age. For these students much of the learning process is difficult because it involves so much reading. The videodisc was particularly useful for them when compared to the alternatives, which are pamphlets and microfiche on various occupations, of the difficult task for the instructors of explaining job rules using sign language. Used visually, there was a great deal of information about each occupation in the motion sequences, and even in the stills, without needing to read the captions or lip read.
>
> The stills formed a database for the students to review, discuss and compare various aspects of the occupations shown, an excellent basis for class activities. pp 73-74.

The videodisc had high novelty value with students and staff and this contributed to the motivation to use it. But the picture was not a simple one. Some of the users found the technology very approachable. Others, particularly staff members who had not been to the inservice course, were reticent to use the material at all, especially when the videodisc was connected to the microcomputer. Not all occupations are represented on the videodisc by still or motion sequence. In one of the trial schools this was reported to be of concern to students who have already formed strong ideas about a possible career for themselves. By having a staff member with the student when they viewed the videodisc it was possible to present an explanation about why the occupation they wanted was not there and what other occupations fell into the same category as the one of their preference. This sometimes led to a desirable broadening of horizons. Some students, if left to use the videodisc alone, flashed through it quickly, not considering what they saw. By using the videodisc in conjunction with other materials or reviewing the information covered in the videodisc with questioning, the teacher was able to ensure the student benefited from using the videodisc.

Overall the evaluation reported that the *Ask the Workers...* videodisc was "notably strong on its positive approach to careers and occupations and hence its motivational value" and compared to ordinary videotapes was "more attractive to students due to its interactive nature". Several other points were noted in the evaluation principally: the production approach was original within the medium; the novelty pays off in educational impact without costing more; the content was valuable; and the very significant benefits for a disadvantaged group were paralleled by very significant benefits for the average student. The final paragraph summarised a positive evaluation:

> The technology of interactive videodisc, especially captioned videodisc with an alternative standalone mode included in the planned modes, is cutting edge technology and must be expected to have not just teething problems but a low chance of demonstrable success. p 95

CONCLUSION

The implementation as assessed by the evaluation team and the project co-ordinator found that although the response was positive, more was expected of the product. Many users felt that it was meant to be a vocational guidance package. It was not. It was designed to stimulate users to think about alternatives and to explore other resources, the research skills developed in the search being possibly more important than the actual information itself. A future link with national databases using public networks such as VIATEL could seek to resolve this problem. Several side issues were effectively addressed by the videodisc, notably several segments on the videodisc were designed to reduce sex stereotypes linked with occupations. Overall, the project did create exploration by users and did encourage rethinking and broadening any preconceived notions of career or occupation choice.

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THE I'M SPECIAL INTERACTIVE VIDEODISC LEARNING SYSTEM FOR TEACHER PREPARATION IN ADAPTED PHYSICAL EDUCATION

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ABSTRACT

I'm Special Interactive Videodisc Learning System was developed at the University of South Florida as a result of a United States Department of Education grant. The objectives of the learning system are to enable learners to state performance points for four movement skills and identify discrepancies of skill performance of handicapped elementary school students. The primary target audience is preservice teachers responsible for providing physical education for handicapped students. It is estimated that the two, thirty-minute level III videodisc sides will provide ten hours of instruction. To date, the I'm Special Interactive Videodisc Learning System has been produced and formative and summative evaluations have been initiated. Hardware for the system is the IBM's AT or Personal System 2 Computer and InfoWindow Display Unit and Pioneer's Laser Videodisc player. Dissemination plans are for up to 50 university and public school departments of education to receive the I'm Special Interactive Videodisc Learning System without charge.

INTRODUCTION

The use of a videodisc learning system as an enabling technology for teacher education has become a reality in adapted physical education with the development of the I'm Special Interactive Videodisc Learning System. The I'm Special Interactive Videodisc Learning System was developed as a result of a United States Department of Education, Office of Special Education and Rehabilitative Services grant. The purposes of the three-year grant, scheduled for completion in May 1989, are to: (1) develop an interactive videodisc learning system, (2) evaluate the effectiveness of the interactive videodisc learning system, and (3) devise a dissemination and training program for university professors and department of education personnel.

PROCESS AND ACCOMPLISHMENTS

The main objectives of I'm Special Interactive Videodisc Learning System are to have the learner demonstrate the ability to: (1) state the performance points for the movement skills of jumping, running, throwing, and kicking; and (2) identify discrepancies in jumping, running, throwing, and kicking performance by handicapped elementary school students. A subordinate objective is to develop the student's skill in applying movement terms to the analysis of skill performance.

I'm Special Interactive Videodisc Learning System includes nine help courses and four main courses. The help courses increase the learner's knowledge of: (1) movement terms, (2) procedures for observing movement, (3) procedures for estimating angles, (4) biomechanics of projecting an object for distance, (5) instructional statements and activities to improve performance in the selected skills, and (6) mature skill performance visual models. The four main courses have practice and verification sections. The practice sections are ungraded learning experiences. The verification section of each main course simulates the role of a teacher by introducing handicapped students and providing access to their medical and educational records. Then each handicapped student's performance in one of the four movement skills is presented for analysis by the learner.

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The I'm Special videodisc, two sides with a total of four, thirty-minute audio tracks, provides self-paced level III interactive videodisc instruction. The primary target audience is preservice teachers responsible for providing physical education programs for handicapped elementary school students; however, the system is appropriate for use with inservice teachers. The I'm Special Interactive Videodisc Learning System allows student individualized instruction with reinforcement for correct responses and corrective feedback for incorrect answers. It is estimated that the I'm Special Interactive Videodisc Learning System will provide ten hours of instruction. A further result of the I'm Special Interactive Videodisc Project has been the establishment of an Interactive Videodisc Learning Lab in the Department of Physical Education, University of South Florida. This lab currently has six level III interactive videodisc learning stations.

I'm Special Interactive Videodisc Learning System uses International Business Machine's (IBM) AT or Personal System 2 Computer and InfoWindow Display Unit, Pioneer's Laser Videodisc Player and IBM's LS1 Authoring Program. Facilities and personnel of the University of South Florida Television Station were used in producing the videodisc. Mastering of the videodisc was completed by 3M Incorporated.

To date, the I'm Special Interactive Videodisc Learning System has been produced and the formative and summative evaluation process has been initiated. The dissemination and implementation training plan is for up to 50 university and public school departments of education to receive the I'm Special Interactive Videodisc Learning System.

Flight Away from Computer Science

by

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The number of students opting to enroll in computer science programs has dropped drastically in colleges and universities around the country. Administrators and academicians are puzzled by the "largest-ever" (according to a recent article in the Wall Street Journal) decrease in the percentage of students selecting a major in computer science. The decrease in prospective graduates is only beginning to affect government and industry. In a market where quality graduates cannot supply the demand that already exists, the decline will have serious ramifications if measures are not taken to correct the situation.

The paper will address the issues in higher education's struggle to determine the possible causes of and solutions to the problem. Recommendations for more appropriate computer literacy/computer science courses at the secondary school level will be made.

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DOES THE COMPUTER MAKE LEARNING GRAPH THEORY EASIER?

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ABSTRACT

This paper reviews the experiences gained over the past four years using four different methods to teach a thirty hour course in Graph Theory to second year degree students. In year one of this study, the method used was "Chalk and Talk"; in year two the computer was used almost exclusively as an electronic blackboard. In year three, there was a mixture of traditional lecture and computer aided learning packages, and in the last year, there were no formal lectures. In the last three years, the notes issued to students contained screen dumps so that the visual memory of the student was jogged when studying the material away from the computer. An open access facility was also provided so that the student could study the CAL packages at any time.

Each year there was an evaluation of student reaction, providing insight into the problems encountered by the learner, and leading to the upgrading of the courseware for clarity. A summary of the lessons learned and a discussion of plans for the future is included.

The CAL programs were written in TenCORE and there is an analysis of the time taken and the problems encountered when a relatively small group of academic staff undertake the production of software. There is also a discussion of the difficulties encountered in delivering the material to students.

BACKGROUND

In 1985, the Mathematics Department at Glasgow College decided to devote resources to CAL, and two of the authors of this paper volunteered to get the project off the ground. The task was to decide on hardware and software and make a start. The hope was that once established the project would grow. It was decided to opt for an authoring rather than a programming language to enable non-programming academic staff to join the project later. TenCORE was selected and by default the hardware became IBM compatible.

With hindsight, the most useful piece of advice to anyone starting out on CAL is to set a deadline for the production of a specified piece of courseware. It is necessary to be realistic. To decide in November to produce programs for a Graph Theory course to be taught in the Spring was probably unrealistic. It was not dissatisfaction with the existing lecture/tutorial system which led to the selection of Graph Theory, but the potential of CAL in this area. After a slow start there was also pressure to justify the selection of what, by British standards, was an expensive authoring system.

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EXPERIENCE

Initially, eight programs were produced to back up most of the material in the course. They were not self contained, but screen dumps were incorporated into the course notes to jog the students' memories when away from the computer. In the first year the computer was used as an Electronic Blackboard to illustrate the lectures, but given the nature of the subject matter, a screen, even with small amounts of animation and colour, was a considerable improvement on either a blackboard or overheads. The computer projection facilities were not good, and hence, when a program was finished in sufficient time, it was loaded onto individual machines and the lecture conducted in the machine room.

Encouraged by student response, the programs were expanded for the next session, making them more interactive and incorporating a multiple choice test at the end of some of the units. It did not seem possible to include many exercises involving proofs in the CAL packages and hence each section of the course had a traditional paper tutorial. No specific time was set aside for problems arising from the paper tutorials but students were encouraged to complete the tutorials along with the associated CAL unit. What happened in practice was that the students progressed through the material covered in the CAL units much faster than in previous years and then had the tutorials to complete at the end. Student feedback indicated:-

1. They would have preferred to have an assigned time each week for a paper tutorial

2. The presence of a lecturer during computer sessions was not essential

3. They would have liked all the notes associated with the course to be handed out at the beginning and not as a particular section was reached.

This course was last taught in the fall of 1988. There were no formal lectures, but the lecturer was present for the CAL work, mainly because of hardware problems associated with the installation of new machines. Non-computer tutorial time was timetabled and all notes were supplied at the first class meeting. The time for the course was reduced to 25 student hours and the students were given a recommended completion date for each section of the course. At the end of term, a multiple choice test (see Ref 1) was administered and the information obtained from this will be used to decide which areas of the course need better explanation. Data from the last questionnaire issued, indicate that almost all of the students agree or strongly agree that CAL is a good way to learn new material and to revise material already known. However there was very strong disagreement with the statement that it was not necessary to have a lecturer present once the operation of the system was mastered. For one of the more difficult algorithms, the students were asked to choose a partner with whom to work. The majority thought this was better than working alone. Predicably the features of the CAL programs liked best by the students were the ability to self pace, the availability of a test with on-screen solutions if required, the challenge the programs presented and the euphoria generated when one was mastered, the clarity of explanation of the topics, the ability to branch and the attractive presentation. The students disliked the absence of proofs, having to ask the lecturer questions, and interestingly, the inability of the system to allow the student to interrogate it.

SUMMARY

It is possible, even with limited resources to produce CAL packages which find favour with students. It also appears that student reaction to too large a reduction in lecturer contact is negative. Comparing student reaction to this course with others on which the authors teach, there is an indication that students like having notes directly linked with the CAL packages.

CONCLUSIONS

The estimated production time of these programs to the present time is 300 hours for every hour of CAL. Many of the skeletons we have developed are being used by other members of our group. This now consists of 7 academic staff who construct CAL packages when they are not engaged in other academic activities, one part-time Research Officer and one temporary full-time programmer. Hence, the initial aim formulated in 1985 has been accomplished. We have faced hardware shortages both for delivery of material to students and development of programs by staff, but being a relatively small, close knit group, we collaborate well in software development. The major problem faced is not unique, namely the rapid growth of technology. The graph theory programs were written in cga since this was all that was available and now a decision has to be taken as to whether to invest time in converting to ega or vga. If these improved graphics facilities are adopted, fewer machines will be available for the students to use.

Evidence suggests that students can accept bugs in the software and still have a very positive reaction to it. The current plans of the CALMAT group involve producing two kinds of traditional packages. One for adult non-standard entrants to College degree courses and the second for high school entrants to establish a common base-line in mathematics. A small section of the group is now investigating the construction of an Intelligent Tutoring System using an expert system shell.

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COMPUTER ASSISTED INSTRUCTION IN CRIMINAL JUSTICE EDUCATION BY COLLEGES AND UNIVERSITIES IN THE UNITED STATES

C B Torres

ABSTRACT

Statement of Problem

When this study was contemplated it was based on two hypotheses. First, Computer Assisted Instruction (CAI) was understood and widely used at the college and university level throughout the United States. Second, if that be the case, it was used in criminal justice education, because faculty by that time (this study began during August 1985) had been trained, and were themselves authoring courseware in criminal justice education.

Sources of Data

Reviews of available literature were conducted in criminal justice education, evolution of the computer, and CAI as used in chemical education. The Rand Corporation reports were reviewed, as were relevant congressional documents. Other government documents as provided by the Educational Resources Information Center (ERIC) were reviewed. Two professors authoring criminal justice education courseware were interviewed at California State University, Sacramento.

Conclusions Reached

Results of the research indicate there is not a clear definition of Computer Assisted Instruction. It is clear from the research, most of the emphasis on CAI by educators and the government is at the K-12 level.

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THE COURSEWARE LIBRARY - A CHALLENGE FOR COMPUTER CENTRES

R Noel Wilson*

ABSTRACT

Provision of computer programs in support of teaching and research is an activity commonly undertaken by United Kingdom University Computer Centres. The paper addresses the issue of providing a courseware support service relevant to the needs of a dynamic institution with an enrolment of some 11,500 students studying in excess of 200 taught courses extending from subdegree level through to higher degrees.

HISTORICAL REVIEW - A NATIONAL PERSPECTIVE

Tertiary education in the United Kingdom (UK), has a strong computing tradition with the concept of an institution-wide service being the responsibility of a central department; the Computer Centre or Computing Service. The role of this department is complementary to that of an academic unit with responsibility for promoting research and teaching computing and allied disciplines.

Generally speaking, up until the early 70's University Computer Centres were financed to provide facilities in support of research. With the "cost decline" in computer hardware relative to its processing capacity, it was accepted that "excess capacity" could be exploited by undergraduates. On the other hand computing services associated with Polytechnics were primarily in support of the teaching function with lesser demand arising from research. In 1975 the UK Government funded an initiative known as the National Development Programme for Computer Assisted Learning (NDPCAL) to promote the concept of Computer Assisted Learning (CAL). Many NDPCAL projects funded within Universities were based on mainframe technology and whilst significant developments took place (ref 1) the rapid pace of technological change with the advent of the "personal computer" and new programming systems, forced a number of these software systems out of currency. In 1982 the Computer Board for Universities and Research Councils (CBURC), the principal funding body for University computing facilities within the UK, established a Working Party to assess the type and level of computing facilities that should be provided for undergraduate training in all disciplines. A report (ref 2) was published in late 1983, highlighting the potential effectiveness of a wider availability of student workstations, but reactions voiced greater concern about adequate software and liveware provision for teaching developments.

Following the recommendations of the report, in 1984, the CBURC and the University Grants Committee (UGC) announced the first tranche of funding in support of "pump-priming" projects to address "Computing in Teaching", known as Computers in Teaching Initiative (CTI) and invited proposals from the University community. A total of 139 projects, at a cost in excess of 7 million pounds, were initiated. The common theme was the exploitation of computing in order to facilitate more effective learning strategies,

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and as a consequence CTI has produced many new software products. To co-ordinate the initiative, support projects and report to the funding bodies, a Computing in Teaching Support Service (CTISS) was established in 1986. The high profile of this unit and its proactive role has led to a recent (mid 1988) announcement of further CBURC funding to establish subject-based centres for the promotion of effective use of computers within the teaching of their disciplines.

The UK is now at the point of exploring the feasibility of the "electronic campus", a concept associated with American institutions since the early 80's, (ref 3,4) but having undertaken a nationwide preliminary review of the pedagogical requirements of its Universities.

HISTORICAL REVIEW - THE UNIVERSITY OF ULSTER

The University was formed in October 1984, through the merging of the New University of Ulster and Ulster Polytechnic. It is the newest University in the UK. The institution is spread over 4 campuses situated throughout Northern Ireland; one at Belfast, Jordanstown, Coleraine and Londonderry. The University differs from the other UK Universities in that it offers several courses at subdegree level and has a strong vocational thrust both through its range of courses leading to examinations of professional bodies and in its structure of degree and higher degree programmes. In 1986-87 approximately 66% of the enrolment was part-time students, a reflection of the aim to "serve the whole community in providing educational opportunity".

The computing service of the new institution is a confluence of supportive services for both teaching and research. Courseware provision in support of the teaching function is especially catered for by a unit of 7 staff who acquire, develop and maintain a comprehensive library of software and supportive documentation; over 500 programs are available.

COURSEWARE LIBRARY

The term courseware is used to describe an item of software and its associated information supportive service, typically user documentation, sample data sets, on-line abstracts and help systems. The concept of a courseware library, analogous to a conventional library of books, journals and various forms of non-book media (excluding Computer Based Training (CBT) or Computer Assisted Learning (CAL)) was conceived in 1971 with the formation of the Computer Centre of the Ulster College, The Northern Ireland Polytechnic (ultimately referred to as Ulster Polytechnic). As the academic development plan of the institution placed a strong emphasis on computing facilities as complementary to other forms of teaching/information dissemination it was a natural idea to support the plan through the formation of a courseware library and staff resource unit.

The evolution of the library may be described as a series of major "landmarks", frequently overlapping. Initially the "team approach" model (ref 5) to courseware development was adopted as there was a clear requirement to introduce academic staff to the ideas underlying effective software production models, and also to generate products with as wide a user base as possible. Software production was undertaken in Fortran and the library existed as a single entity on a processor used primarily in batch processing mode but with a constantly improving interactive capability. Support documentation was "typewriter produced" and managed manually.

Consistent with the theme of the paper, the second development phase (and first major challenge) coincided with computer replacement in 1979 when a DEC VAX service was introduced, offering a significant interactive capability. Around the same time period, the support unit also recognised the need to increase the rate of growth of the courseware service and switched its policy towards acquisition. There were a number of national developments following NDPCAL, which led to the establishment of software exchange libraries; these libraries and sources of material in America (Conduit, University of Iowa; Cornell University) and elsewhere were exploited. Courseware portability became a major factor leading to new software production standards (ref 6,7). In parallel with software conversion work, the potential of the interactive environment was harnessed to create an on-line information server. This development involved the production of an in-house courseware classification system and providing a database of abstracts for each courseware library item. As major revisions to user documentation were necessary a further policy change introduced a dedicated wordprocessing facility for document creation and storage. Both information services were "linked" in that the on-line information server referred to the printed form of the guide as the next level of courseware information. Similar, and more complex, systems exist elsewhere (ref 8).

Whilst these activities were coincident with the introduction of the microcomputer era, no courseware development for this hardware platform was feasible until 1982-1983. Resources used to support the courseware service required refocussing as academic staff research matured and a demand arose for "more advanced" software products, typically major proprietary systems. This category of software did not fit conveniently into the courseware library philosophy nevertheless due to expertise in software porting and support being associated with the courseware support unit it was logical to broaden the remit of the group.

The "search radius" for software acquisition continued to expand and with the transition to a new hardware platform which was widely accepted within the academic community the group were able to offer courseware to other sites. Several UK distributions have been undertaken both to institutions and libraries, with requests for software being received from as far afield as Scandanavia, Africa and Singapore.

Activities to date relate to Polytechnic developments; premerger software support at the New University of Ulster was predominantly for researchers and concentrated on a core of well established systems.

Following the formation of the merged institution came the next major challenge; that of providing and maintaining a distributed coureware library. A single vendor environment on all four campuses meant the task was not as formidable as it may have been. There are however the issues of management; that of ensuring currency of courseware, rationalisation of specialist services, for example Computer Aided Engineering (CAE), graphics; and a common user interface. In addressing issues of this nature it has again been possible to strengthen professional practices and standards, particuarly in the area of interface design (ref 9) although because of limited availability of graphics and intelligent character-based display units compounded with the man-years of effort to modernise existing software, progress has been slow. Parallel developments include an expansion of the service to produce products specifically for micro-based platforms, and devise appropriate development strategies (ref 10). Finally, recent initiatives by the CBURC, including CTI and "bulk software deals" on behalf of the UK University community, further accelerate the transition towards multi-vendor environments. Whilst the software deals are associated with proprietary systems and not limited to conventional CAL, CBT products, the need for this form of software service continues to grow. Demand reflects the vocational emphasis which is a consequence of the philosophy the institution; that is to offer a "wide range of academic and professional courses which are both intellectually challenging and vocationally attractive".

THE FUTURE

The inability to match the pace of technological developments, both firmware and software (programming languages, tools and operating environments), in terms of providing a courseware facility with a user interface consistent with pedagogically acceptable market trends, must mean "future developments address the past". For example enabling technologies such as expert system shells, hypermedia environments, multi-media databases and advanced forms of user interaction with computer models (ref 11) hold immense potential in terms of their capacity to enhance the teaching/learning role of computer technology. Compounding these technologies with integrated microcomputer networks, wide area networks (WAN's) and the management of a "multi-vendor-multi-architecture" courseware library service which is constantly subject to change in unison with academic planning provides a challenge which is even more revolutionary than those experienced in the past 18 years. The proper balance in distributing resources between development, acquisition, academic staff training and other supportive services must be achieved.

Already the service has expanded to provide tutorial management facilities on networked microcomputer clusters and the range of applications supported is growing.

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SOFTWARE ENGINEERING - ACTUAL UNIVERSITY EXPERIENCE

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ABSTRACT

Undergraduate computer science students at National University, San Diego Region, North Sector Campus, must complete a unique intensive software engineering course as a requirement for graduation. The curriculum is designed to both reinforce prior learning and to immerse students into an environment representative of a real industry software development project. Thus students have the opportunity to apply first hand many of the technical concepts they have learned, and to experience a myriad of other software development problems as well. Upon completion, students successfully develop a non-trivial software program of their choice and have a solid understanding of the realities of software engineering - an understanding which, we believe, can only be experienced. This paper describes the rationale and objectives of the curriculum and presents information for other educators who may wish to incorporate a similar course into their own curricula.

OVERVIEW

The authors contend that a computer science graduate must not only have an understanding of the traditional subjects, (theory and practice), which comprise his or her chosen field, but also a solid grasp of how these topics relate and interact with one another.

Unfortunately, traditional computer science problems and exercises tend to be of insufficient size or complexity to produce the desired results. Thus the resourceful student can usually devise shortcuts or alternate pragmatic techniques to solve the immediate problem and not appreciate its true significance. We have no problem with student ingenuity in solving problems. However, we do wish to discourage students from devising solutions which when applied to a real life issue will be counter productive. Thus the role of the

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school and the instructor is not to discourage the student's creativity; rather, it is to present the problem in such a way that the student's solution is a useful one which, in turn, justifies the learning experience. We believe that the culminating project described here meets the above criteria and is a fitting conclusion to the Bachelor of Science in Computer Science degree program.

National University's software development course stresses the student team approach and requires that the professors, who are outstanding professionals in their field, play a very active role in the process. Of prime importance is student performance with the actual software engineering procedure.

Project scoping and monitoring are on-going tasks performed by the professor who takes into consideration team skills and abilities of each student during every software development phase. Grades are given each month for the team's progress towards completion of the assigned deliverables required during that software development phase. For each deliverable, the target software must adequately address the scope of the level of coverage. Each deliverable completely describes and includes all the inputs, tasks, and outputs. For each deliverable, the level of coverage varies in size and complexity based on the nature of the problem and the software being developed.

Students' progress is evaluated as follows:

1. Needs work
2. Sufficient
3. Average
4. Acceptable
5. Excellent

PROBLEM

Three years ago, undergraduate computer science students were most anxious to demonstrate their "coding" skills. Although they were aware of the software crisis, they did not understand its relevance or the need for a software engineering discipline. All students were given the same programming assignment, for example to create a word processor or spreadsheet. At the end of the course, some projects were incomplete, some were poorly planned, some were paper tigers, most were just academic exercises.

Although the students were happy to get through the operation, they did not feel that their work was worthwhile or practical. Most students did not understand that design flaws are still the major problem with software maintenance in industry today. Therefore, the programs were not devised properly before coding.

SOLUTION

The senior level computer science course is designed to focus on problem solving of real world business situations and transform these solutions into computer software. Students apply their basic software technical skills and knowledge within a defined software engineering process. The focus to their work is on quality design based upon understanding of the target user requirements. This challenges individual commitment, communication, competency, and creativity. The overall goal is to develop a worthwhile project, one the students would be proud to present to their friends, family, prospective employers, and target software users.

SOFTWARE ENGINEERING PROCESS AT NATIONAL UNIVERSITY

National University's software engineering process, adopted as the basis for the senior project development, provides the means whereby software is designed, implemented, tested, and documented. The process consists of three independent phases, each of which has key project inputs, tasks, and outputs necessary to complete the major project deliverables. At the completion of each phase the project deliverable is graded for completeness, quality, timeliness, and commitment to design details.

PHASE 1:
- Software project definition
- Project plan
- External program design

PHASE 2:
- Internal program design
- Program test plan

PHASE 3:
- Program user document
- Program presentation
- Software program

To monitor the project, each student must submit biweekly status and exception reports. The project leader, responsible for the overall project, meets regularly with the professor to discuss project status. Industry experts are present during the final project presentation which is held at a major computer engineering corporation marketing demonstration room. Quality, documentation and the actual program continue to improve with each successive class. During the most recent student project presentation, the end users were so impressed with the quality of the program that they plan to use it to improve work productivity. Students, encouraged by end user acceptance, plan to market their software package.

SUMMARY

National University continues to introduce changes in its computer software education to significantly increase the benefits side of the student cost-benefit calculation. Although it is difficult to design and teach a software engineering course such as this one, current strategy demonstrates two sparkling insights that were not at all obvious when the course was first designed in 1985.

First, if one pushes the educational requirement out far enough from the traditional classroom, not only could it be well received by the students, but the small business end-users would also benefit from the student creativeness and innovative quality software. The challenge is to match the business end-user's need with a team of dedicated students and obtain "quality software" at the completion of the course. In addition to students' efforts, the success of the project depends upon the instructor's project management experience, persuasion and enthusiasm throughout all software development phases.

Second, although in 1986 there were not many software development tools available for classroom use, the software engineering discipline taught the students for the first time in an academic environment that a broad-based need for "quality personal computer software" exists and is achievable by a software team. Graduating students continue their software careers with an appreciation of the software development process and seek better, more efficient techniques to improve the software development process in their respective jobs.

The Automated Curriculum-based System

Joyce L. Hart*

ABSTRACT

A Goal of Florida Community College at Jacksonville was to unify the services among the College's campuses and centers of instruction. The College already had established a College-wide Curriculum Action Process that required manually selecting and filling out forms to accomplish a desired result. The elements that compiled the contents of the Course Outlines and the College Catalog were all developed, deleted, or updated through the Curriculum Action Process. The manual process required, copying, noting, storing and rekeying appropriate elements from the proposal to eventually get them into the appropriate files/systems. Using existing equipment and software, the College automated and interfaced all three projects within one year.

As a result, the Curriculum Action Process, the Official Course Outlines, and the College Catalog became accessible for display by electronic mail college-wide from anywhere in College Administration or from the four campuses via terminal or microcomputer connected to the mainframe.

INTRODUCTION

Florida Community College at Jacksonville has an administration building and four campuses geographically spread out over Duval County, to serve both Duval and Nassau Counties on Florida's Northeast (Atlantic) Coast. In addition, the College has established hundreds of off-campus centers of instruction.

INSTITUTIONAL GOAL

The College emphasizes a one-college concept to unify the services among the campuses and centers of instruction. A College goal to help accomplish this, among others, is the computerization of College Data for management, application, processing, review, and college-wide communication. The Automated Curriculum-based System designed by Joyce Hart, Curriculum Services Officer, at Florida Community College at Jacksonville (FCCJ) addresses that goal.

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David Burrows, Information Systems Officer at FCCJ implemented the project.

SYSTEM PROJECT

The System is a model in communication, curriculum innovation and development, and instructional resources. The project to automate and integrate three major systems (The Curriculum Process, Official Course Outlines, and the College Catalog) was approved by the College, and fully developed and implemented during the 1987/88 Academic year.

BACKGROUND

The College already had established a College-wide Curriculum Action Process that supported the one-college concept and structure. It required manually selecting and filling out forms to accomplish a desired result, and several manual modifications as a result of time-consuming college-wide review of the duplicated hard copies. The elements that compiled the contents of the Course Outlines and the College Catalog are all developed, deleted, or updated through the Curriculum Action Process. The manual process required, copying, noting, storing and rekeying appropriate elements from the proposal to eventually get them into the appropriate files/systems.

The College also had established common official course outlines for its active college credit courses, the number ranging from 700-900 total active college credit courses. The outlines were maintained in personal computer word processing software DisplayWrite 3 on floppy discs. The Outlines are developed and updated via the Curriculum Action Process. These outlines are the bases of the course syllabi that faculty are expected to prepare and distribute to students.

The College produces a College Catalog annually with the greatest volume of its contents being curriculum-related, i.e. programs of study, course descriptions, course fees, etc. The College Catalog contents also were word processed using personal computer software DisplayWrite 3, on floppy discs. Curriculum-related actions that occurred continuously were noted or copied, and stored somewhere until the period of time was scheduled and word processors hired to reflect the curriculum items on the discs. The discs, then, were the source of the catalog content in the printing bid specifications.

AUTOMATION AND INTEGRATION OF THE PROJECT

The Automation of the Curriculum Process was requested by the users to facilitate filling out the forms and College-wide faculty administrative review and communication. That was scheduled for implementation during the 1987/88 academic year. In the Summer of 1987 Joyce Hart proposed that, since the Official Course Outlines and the College Catalog are major projects which contents are compiled from the curriculum proposals via the Curriculum Action Process, a plan for the automation and interfacing of all three projects be proposed. The Associate Vice President for Computer and Information Systems agreed to consider the automation of the three as a unit. The Vice President of Instruction requested that Joyce Hart and the Associate Vice President draft such an integrated plan and pursue it to final stages. The draft of the plan was completed early in August, 1987.

The Associate Vice President involved Dr. Dave Burrows and Ms. Hart involved Ms. Kay Pope, Curriculum Services Specialist, to review the draft and recommendations to cover implementation details from both the data processing perspective and the user perspective. These four people, were directly involved and instrumental in the testing and final recommendations, as well as the implementation of those recommendations. As needed, an IBM representative for guidance and trouble-shooting was called in.

Based on the common conclusion among the participants that the concept was both feasible and expedient, a pilot project was proposed for the month of September, 1988, to upload and input limited segments of the three projects for testing. During September, each action, including copying from one file to another, was attempted and evaluated for practicality and user-friendliness.

The results of the pilot project established the practicality, effectiveness, resources, budgets, and required time schedule for implementation of the overall Plan. It received Institutional approval to proceed and funds were provided to contract for a technical support person to handle the detail input, file conversion, testing, writing user and manager instructions, and training. That back-up assistance covered almost seven months for 20-30 hours a week. Activities during this time included:

- Conversion of word processed outlines, curriculum process forms, and college catalog content to RFT format and uploaded to the mainframe computer

- Technical designation of mainframe storage, set-up, and access

- Internal testing

- College-wide demonstration and testing of each of three major portions of the project

- Trouble-shooting systematic and technical problems
- Writing user and manager instructions
- Setting up and testing security
- Setting up adequate user access

In that existing equipment and software and current computerization plans were used as the basis for the automation plan, the implementation costs were minor. The College's plans for computerization already included 300 direct accesses via terminal or personal computer to the College's mainframe, located at strategic locations college-wide. Systems printers being purchased and installed are used to facilitate the printing of draft or review copies of the various files. However, the printing is discouraged to take advantage of the on-line aspect of the plan.

SUMMARY

With the implementation of this project, the Curriculum Action Process the Official Course Outlines, and the College Catalog, are accessible for display by electronic mail college-wide from anywhere in College Administration or on the four campuses via terminal or microcomputer connected to the mainframe. The Curriculum Process shells (forms), are accessed, the appropriate combination chosen, filled in on-line, and compiled into a "proposal" from any mainframe connection at the College, electronically transmitted college-wide for review, and, subsequently, updated by the originator. Finally, specific elements from the approved curriculum proposal are "copied" from the file into the Course Outlines file and the College Catalog file without rekeying the details. These files then are accessible on-line college-wide for viewing, with user-friendly "Find" features.

The automated Curriculum Action Process was the final portion completed, tested, and presented college-wide. As each portion of the plan was implemented, orientation and demonstration sessions were held in the mainframe labs on each campus. The sessions were designed to address the needs and applications of each specific group of users. These sessions have continued as needed. The automated curriculum action process is currently the only method acceptable for processing curriculum.

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THE COMPATIBILITY DILEMMA: Fact or Fiction

W. G. Mitchell*

ABSTRACT

A brief overview of the Ontario provincial program in computers in education is given, with particular reference to hardware procurement and educational software development and acquisition. The issue of software compatibility is then discussed in two senses: compatibililty with provincial curriculum policy, and compatibility between and among several different microcomputers. Ontario's approach to resolving the compatibility issue is then explained in terms of a software solution.

INTRODUCTION

Canada is a Confederation with certain powers given by constitution to the Federal Government, and others to the Provinces. Education is a provincial responsibility, and hence Canada has about as many policies on computer education as it does provinces (and there are ten of these). Yet all provincial ministries of education share a deep concern about computers and their use in education, and all have established plans related to bringing about the most effective way or ways to implement computers in educational settings.

It is interesting to note that the adoption of the computer as a tool which can usefully serve educational purposes has come about with surprising rapidity. Change in education is something which tends to occur very slowly: one thinks almost in terms of geological glaciation, with changes seen in light of twenty, thirty, or even one hundred years. In addition, such changes are very difficult to bring about. Parents have very strong opinions concerning how their children are to be educated, and are often very reluctant to move away from what their own educational experience has been. Thus the adage: "Everyone's in favour of progress; it's the changes they don't like."

It was after all only in 1976, I believe, when the first commercially successful microcomputer, the Apple, came on the scene. In the intervening thirteen years a literal explosion in numbers and types of microcomputers has occurred and that explosion has been world wide. Without a sound strategic planning structure to cope with such change, educational policy makers would find decision making difficult, if not next to impossible.

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INITIAL STEPS

During the period 1978 - 1982, the strategic planning process in the Ontario Ministry of Education had identified education technology as having enormous potential to assist learning, if one principle could be rigidly adhered to: technology should serve pedagogy, not the other way round.

If this could be done, it would alleviate the following problem, put very succinctly by Edward Fiske in the New York Times (June 29, 1988):

"Local school boards, eager to equip students for a technological society, seek out the computer seller that will give them the most for their money. When the machines arrive, teachers try to find good software... (then) look for students who can benefit from them. The result is an Alice in Wonderland situation, in which teachers are... looking for students with learning needs that coincide with software that was acquired because it works on a machine that was bought for essentially economic and political reasons."

As Fiske's remarks make clear, to pursue educational technology from strictly a hardware perspective can lead to a rather nasty cul du sac. Ontario has taken a very different approach, and at least to this point in time, has avoided entering the hardware trap quite so dramatically. That is, the Ontario initiative has been, since its inception in 1982, primarily software-driven rather than hardware-driven. The need for highly interactive, networked software led to the creation of the UNISYS ICON microcomputer, the first government-subsidized grant eligible microcomputer system (G.E.M.S. TM) to be followed later by systems from IBM and Commodore. This accent on software is the strategic foundation upon which Ontario's program rests, and leads to a possible way out of what has been termed "The Compatibility Dilemma".

THE COMPATIBILITY DILEMMA

There is an old saying, that when one is on the horns of a dilemma, one can always escape by throwing sand in the bull's face. A possibility, but only if one thoroughly understands the nature of the horns, and has access to sand. In Ontario's case, the horns were the computers themselves - no one machine, in terms of software, compatible with any other - and the sand was composed of educational software. The "throwing" was in terms of government policy, and perhaps this is as far as one should push metaphor.

This policy has two components: software development by the Ontario Ministry of Education, in cooperation with the educational community and the private sector, and the development of a software portability environment which will ensure that Ministry - produced and licensed educational software will run on a variety of computers.

With respect to education software development, such software is inherently compatible with Ministry curriculum policy guidelines, in that such compatibility is the prime criterion upon which government funding for such software is made possible. To date some 140 programs have been produced and disseminated to Ontario schools, at a cost of $27.7 M (CAN). Where commercially -produced educational software is concerned, a Provincial Committee, comprised of Ministry officials, teachers and administrators, identifies software that meets local curriculum needs. The Ministry then proceeds to negotiate standing offers with the producers of that software, to take advantage of economies of scale. This is a three year program, with $13.9 M (CAN) assigned over the three years.

However, with three different computer systems approved for grant subsidy, and the likelihood of several others gaining approval in the near future, the incompatibility issue becomes urgent, if Ministry - developed and licensed software is to run on all approved systems.

Ontario has worked to resolve this particular incompatibility issue through the development of a software portability environment, termed "EASI". The initials stand for Educational Application Software Interface, and I would be remiss at this point if I did not acknowledge the superb work of our Coordinator of Technical Development in the Ministry's Computers in Education Centre, Dr. J. W. Vraets, who brought the EASI concept to fruition.

Put simply, EASI is a small collection of computer software elements which can be linked into a software developer's program as part of the normal production of a distribution disk master. Copies are made for school use by commercial duplication services.

The elements which form the EASI are contained in a software development tool kit called a 'library'. Each of the elements in the library acts as an adaptor coupling between the software developer's standard program and a unique computer. The software developer uses a standard program and a unique computer. The computer vendor written (and maintained) toolkit deals with the computer's unique manner of providing that service. The vendor is then free to update the computer system at any time without significantly affecting the software developer's 'source program'.

In simple cases, to prepare the software developer's program for distribution, the developer in turn links the program with each of the different computer's EASI libraries. The result is a master copy of the distribution disk for each different type of computer. In more complex cases, it may be necessary to do some limited manual revision to the 'source program' to deal with specific computers. This can arise from compatibility problems which, in specific cases, cannot be resolved. Because the programs are easily converted, they are referred to as 'highly portable'. The software development is said to take place within a 'software portability environment', and the technical details of this environment are available from the Ontario Ministry of Education.

In conclusion, I had earlier referred to the strategic principle governing Ontario's program in computers in education -that technology should serve pedagogy. The development of curriculum - aligned software, coupled with the EASI Interface, are, I believe, two outstanding examples of that principle in action, and go some distance towards resolving the compatibility dilemma.

USING PORTABLE TOOLS TO DEVELOP EDUCATIONAL SOFTWARE

A J Fyfe*

ABSTRACT

Late in 1985 a small group of educational software developers met to discuss the problems associated with the use of graphics in Computer Assisted Learning (CAL) packages. A series of such informal meetings were instituted to research, discuss and try to define problems and solutions. As a result the Inner London Educational Computer Centre (ILECC), initially in collaboration with the MEP Software Unit and latterly with SCET, have produced the ILECC Graphics System (IGS) which is a graphical programming environment based on the underlying concepts of the ISO standard GKS. The paper "Educational Requirements for Software Portability" (Ref 1) describes some of the advantages which might be gained from the development of such a system. This paper will concentrate on the experiences of ILECC and The Scottish Council for Educational Technology (SCET) in using IGS to produce educational applications and comparisons will be drawn between the expected benefits described in Ref 1 and the subsequent practice.

THE IGS EXPERIENCE

As a result of the development of IGS and experience gained through its use in the production of other packages, it is now possible to discuss the advantages and disadvantages of this approach and to suggest ways in which its use may be facilitated in the future. The first point is that a portable graphics package may provide a way of dealing with some of the problems of versioning but, even if it met all the requirements of software producers in terms of graphics facilities, there are other aspects of a computer program which will cause portability problems and which have nothing to do with graphics. Other libraries will have to be produced to deal with other aspects of the program such as file handling and peripherals.

Also, standard graphics packages such as IGS, have features which are not always helpful for software writers. Generally, these stem from the fact that portability is achieved by forcing programmers to work with a virtual graphics screen which may be fundamentally different from the real screen on which the output will be displayed.

The principles used by IGS are based on those in the Standard Graphics Kernel System (GKS). Programmers will decide on the co-ordinate system (known as the World Co-ordinate System) which will be used for an application and different units of measurement can be used in different applications. The IGS will transform these co-ordinates into the device co-ordinate system which has 16,384 pixels horizontally and 13,000 vertically. It is this co-ordinate system which provides the device independence from which portability stems. The IGS version for any particular machine will transform objects in the device co-ordinate system to be displayed in a certain mode on a particular device.

In most circumstances, this provides device independence in a most effective way and illustrations can be created which can be displayed on screens as widely varying as 40 column RM Nimbus pc, 40 column IBM pc CGA, IBM pc EGA 640 x 350 and Acorn Archimedes mode 20. However, the differences in resolution cannot be totally ignored and it is only to be expected that a graphic image which is perfectly acceptable on IBM EGA 645 x 350 may be unacceptable on IBM CGA 320 x 200.

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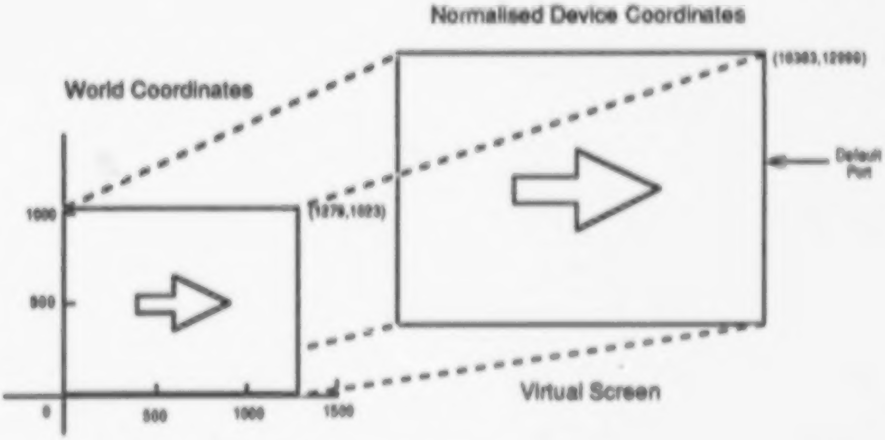

There can be other problems which occur when the difference in resolution is significant and limited to one dimension. On the Nimbus pc 40 column mode has resolution 320 x 250 but on the IBM pc in CGA mode the screen has a resolution of 320 x 200. The IGS will be able to display the same graphic on both systems but the appearance will be significantly different because of the different aspect ratio on the two screens. For some applications it will be important to ensure that the aspect ratio is preserved when the program is displayed on different screens. Thus, in a geometry program, for example, it may be necessary to be able to reproduce squares and circles exactly on different screens. The form of portability provided by IGS will not provide this facility unless the aspect ratio of pixels on the screen is preserved. This problem is compounded by the fact that the dimensions of the physical screens may vary from one model to another, even if the resolution, as defined in terms of pixels, is constant.

A package such as IGS works best when dealing with pictures which consist of collections of graphics objects such squares, rectangles and circles constructed with lines of various colours and styles and possibly filled in solid or hatched patterns. This leaves two areas of difficulty, the first of which concerns text. The easiest and the fastest method of displaying text will be to use the default system font for the particular mode in use. A string of text which looks good on an Archimedes in a 40 column mode may be totally unacceptable on an IBM CGA display. Similarly, text created for display on a 40 column screen will look strange if displayed on an 80 column screen although the IGS will be able to do so easily.

Some of these difficulties can be avoided either by restricting the range of modes in which one expects the program to be displayed or by ensuring that the program uses fonts other than the normal system font which are more appropriate for the application concerned. This latter approach places an additional burden on programmers both in ensuring that such fonts are available and in finding the most appropriate one for particular applications. The creation of a range of fonts for the different versions of IGS currently available is a sizeable task for which resources are not available at present.

The final problem occurs in programs in which animation is an important part. There are some forms of animation which can be implemented satisfactorily on a system such as IGS but there are others which pose some problems. Generally, trying to reproduce the effect available on many new machines of moving multi-coloured sprites will be difficult for a package such as IGS. Sprites depend on the use of special routines to manipulate sections of the memory used to store the screen display. A package such as IGS deliberately avoids such techniques because they will not be portable.

CONCLUSIONS

The most important point to make is that it is possible to create a standard graphics system which will allow software to be versioned easily to run on a wide range of microcomputers. It also has to be accepted that in some applications there will be difficulties but some of these can be minimised by limiting expectations about what portability may provide; in particular, it cannot be expected that all programs will run acceptably on all displays on all microcomputers. This leads to consideration of providing support only for a limited range of modes on certain machines which would happen to facilitate portability. Unfortunately, when the range of resolutions to be encompassed is taken into account it is difficult to see a simple selection of two, or at most three, resolutions which will cover a wide range of manufacturers. Nevertheless, this possibility is worth pursuing, particularly for benefits to be gained for software which is only beginning development now. It is for reasons such as these that the Ontario draft Stage II Functional Specification (Ref 2) states that all conforming systems should provide a mode with 640x480 resolution and 16 colours for which commissioned educational software should be written.

It also has to be accepted that there are some aspects of computer programs for which technical portability is not sufficient. Examples of these have already been given earlier and include drawing squares and circles, using text and colour. A system such as IGS will facilitate the production of a version which will run on another machine but further work may be necessary to find the best combination of colours or the most appropriate font with which to display text in order to get an application which is more acceptable to users.

Experience of using IGS to develop real applications highlights the fact that the graphics system deals with only some of the problems of writing applications. In particular, problems associated with file handling are just as common. Even in those cases where the facilities of IGS are well suited to providing portability of graphics features in a program it is highly likely that there will be file handling aspects which are not. There is an urgent need for software development organisations to consider these problems in the same way that SCET and ILECC have considered the graphics problems. However, the reaction of other IGS users is encouraging. While they may be aware of the problems they are also appreciative of the fact that there is a library of functions which is available on both MS DOS and Acorn machines.

The main problem is whether educational organisations can or should try to keep pace with the technical changes in the marketplace. There are clear signs that the type of microcomputer being supplied by manufacturers now is significantly different from that available in 1986 when work began on the ILECC Graphics System. Users expect manufacturers to provide a wimp environment with new micros and again manufacturers are taking the opportunity to build their own proprietary features into these systems. Undoubtedly Apple leads the way in this world by providing a comprehensive tool-box for programmers to use. Having shown that some of the problems can be addressed by packages such as IGS, a new set of problems is now emerging. Should educational software developers "give in" and accept a proprietary commercial system or must we continue to "patch" the different environments available, particularly from the leading UK educational manufacturers Acorn and Research Machines? The SCET experience suggests that limited diversity can be accommodated and that the production of packages such as IGS should continue to be given a high priority by SCET.

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THE COMPATIBILITY DILEMMA: SHOULD THE TAIL CONTINUE TO WAG THE DOG?

Nolan Estes* and William Gattis**

ABSTRACT

Each year school districts spend millions of dollars on computers. Others plan to make major investments in computer hardware, operating systems and applications software in the near future. A proliferation of small computers can be found throughout the nation's school systems being used for a variety of administrative and instructional management functions. Yet, while use of these systems continues to grow and expand, a major problem still exists regarding compatibility.

There is clearly a need for improved techniques to achieve compatibility among various computer systems -- not only among different computers and operating systems which exist now, but also to meet future needs. Until computer vendors accept the challenge to develop new software to meet the issue of compatibility, an increasing number of school districts will delay or scale down major purchase or implementation plans. If districts are to continue making major investments in this area, they deserve assurances these systems will make the grade in terms of compatibility, software support and system maintainability.

INTRODUCTION

Use of the small computer for administrative and instructional management functions has become fairly common in K-12 public schools today. Across the nation, in medium and large districts, major investments continue to be made for microcomputer based administrative systems. In fact, planned expenditures in this area will equal or exceed what will be spent on computers used for classroom instruction.

Applications in these administrative and instructional management functions include the following trends:

-- In the area of instructional management, the small computer is being used both for software-based instruction and for management of instruction using traditional print materials.

-- Small computers are being more widely used for the basic educational administrative functions: student enrollment,

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scheduling, grade reporting, and attendance. Additional applications have extended to finance and purchasing, personnel data bases,student data bases, access to central office mainframe computer systems, textbook and school equipment inventory systems, word processing, guidance functions, and library services.

-- Becoming increasingly popular is the use of small computers networked to share data resources.

-- Improved processes and techniques have made it possible to mesh software applications used for instruction with software systems used for instructional management and administration.

In the midst of all this activity, small computers continue to be developed with faster processing speeds, larger amounts of memory, more economical costs, faster and less expensive mass storage devices, and more sophisticated operating systems. All these improvements make the expansion of the small computer into areas of educational adminstration logical and feasible.

THE DILEMMA

As the small computer becomes commonplace in K-12 schools, large district users, particularly those expecting to make substantial investments over the next few years, find themselves faced with a major dilemma. School districts planning to making major expenditures are forced to make decisions based on the long term. Such focus is often in conflict with the fast changing technology of the small computer. As new systems are introduced, the rapid obsolescence of many hardware and software products is a major concern for school officials.

For example, a metropolitan school district with a student enrollment of 50,000 implementing a typical microcomputer-based system for district wide use could spend up to six million dollars. Computer hardware costs alone could account for as much as 60 to 70 percent of the initial investment, with software licenses, hardware and software service contracts, and supplies making up the balance. In addition, the district will incur costs related to training of personnel and adaptation of other related or interfacing systems, procedures and methods.

However, because of the continuing evolution of computer systems and the replacement by manufacturers of older models with new ones, the system purchased by that district will be difficult or impossible to update or expand in as little as two years time.

It's true the continuing development of new and improved models offers increased performance and lower costs; however, as a result of this process the major school user can find a substantial investment in a mocrocomputer-based system increasingly difficult and expensive to maintain.

For these users, betting on the long term compatibility of current computer and software products with newer systems that lie a few years in the future can be risky business indeed.

It's no wonder then a growing number of medium and large districts are asking vendors about issues of compatibility, software support, and system maintainability, prior to making major investments. And because an increasing number of school districts are not receiving the assurances they want, they are delaying or scaling down major purchase or implementation plans.

COMING UP WITH A SOLUTION

The conflict of continuing innovation in computer technology and the resulting obsolescence of investments in computer systems and software is not new. Computer users have faced this problem since the early 50's.

It's a fact of life and good business that computer companies, looking at ways to increase sales and revenues and improve profitability, can justify an expensive transition to newer, upgraded systems. However, in education, revenues are not often directly related to improved efficiency or to improved quality of the end project. Unlike the business enterprise where the decision to upgrade is a simple one, the decision in a district to replace serviceable but outdated systems with newer ones is seldom clearcut. Educational institutions typically use existing facilities and equipment for a far longer period than the average business operation.

The central issue remains one of compatibility -- compatibility not only laterally across different systems but longitu*dinally into the future. Clearly a need exists for improved techniques to achieve compatibility among computers and operating systems.

Various standards have already been presented as solutions to partially address this compatibility concern. Some examples are the 5 1/2 inch floppy diskette and various magnetic tape formats, language standards such as BASIC or COBAL; and information interchange standards such as ASCII code. While worthwhile, they still impose limitations for both users and developers of applications software.

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Yet another approach to standards does not depend on language,media, or operating system. Instead that approach depends on developing methods of defining specific applications envelopes for computer systems, that is solutions designed for specific computer users. These solutions are presented as carefully defined data structures that can be designed and developed independently of any specific computer hardware, programming language, or operating system.

The data structures deal with individual applications and with functions unique to a specific application. In their design they deal only in a general way with the capabilities of individual computer systems. A general purpose adaptive softare utility developed for each computer system addresses specifics of interaction with individual brands of hardware and operating systems. It interprets the elements of data structure and drives the individual computer system accordingly.

The concept is not new, and extensive and effective implementations have already been developed in other areas of the computer industry.

One reason these types of data structures are so successful is that in order to be useful, they must be based on a common threshold of capabilities across systems. Once established, however, the processes can be extended to take advantage of new capabilities, thus eliminating the obsolescence factor.

For anyone engaged in the use of computer systems in education, the issue of standards is a critical one. If districts are to continue making major investments in this area, serious attention must be given to finding realistic alternatives to current practices. As educators, we must challenge vendors to seek those alternatives.

PORTING EDUCATIONAL SOFWARE: AN IKBS APPROACH

D.J. Atkins [1] and M.P. Thorne [2].

ABSTRACT

This paper discusses POSTMIB, a system which learns about various versions of source language during user interaction and stores such knowledge for later use. An object version is produced automatically. In experiment the success rate has been very high with complete translations being produced virtually automatically.

BACKGROUND TO THE PROBLEM

For a software house wishing to address the educational computing market, one of the major problems is that there are so many different types of microcomputer now available. The following table shows the range of microcomputers in use in education:

	Scandinavia	Germany	Benelux	France	Italy	Spain	U.K.	U.S.A.
Apple II		*	*	*	*			*
Macintosh	*	*		*			*	*
Atari		*			*			*
BBC			*		*		*	*
Commodore 64	*	*	*	*	*	*		*
Compis	*							
Goupil				*				
IBM PC	*	*	*	*	*	*		*
Olivetti	*				*			
Philips			*		*			
RML							*	
Thompson		*		*				
MSX						*		

For educational software houses the problem is particularly acute. Software producers need a sufficiently large market to sell enough copies to recoup development costs and to support new product development. Also versioning depletes the resources available for this, and is itself very costly.

For educational applications, BASIC is the standard language that runs on most available microcomputers. Each microcomputer though, tends to have its own version of the BASIC language interpreter and, in particular, its own idiosyncratic graphics and sound facilities. So every educational software package that is released must be re-written in all the different versions of BASIC relevant to the educational market. There is also the problem of producing programs for newly released microcomputers as soon as possible after they are put on the market.

There are several different ways in which problems of this general kind have been approached by other researchers. First, and perhaps the most obvious solution, is to use a defined standard for the computer language in which programs are to be written. Programs written in this way can then be used on any computer that provides an appropriate environment, whether it be an interpreter or compiler, for the program to run in. Two good examples of this are the PFORT verifier (Ref 1) and the PBASIC verifier (Ref 2).

On the whole, the underlying structure of the different versions of the BASIC language implemented on microcomputers in current use is fairly similar. This fact was exploited by the inventors of the BASIC language subset called BASICODE (Ref 3). Programs written in BASICODE can be run on a variety of microcomputers without alterations. The BASICODE language merely consists of a collection of commands common to all the supported versions of the BASIC language, supplemented by several machine code routines for machine dependent functions, e.g. for positioning the cursor or clearing the screen, where these commands are not available directly. Unfortunately, in BASICODE no provision is made for high resolution graphics, the very area where many of the main differences can be found in most BASIC implementations.

Another way of achieving portability of software is to use an intermediate level interpreter to run the program. A good example of this is the UCSD P-system (Ref 4). It uses a compiler that produces a P-code object program. P-code is a portable low level language designed so that the effort in porting an interpreter for it is minimal. The object code is then passed through a P-code interpreter which performs the actions required to run the program. Machine dependencies are taken care of by the interpreter.

Quite recently European Educational Software have taken up this idea of a virtual machine to try and solve the problem of transporting software between various microcomputers (Ref 5). Their aim is to provide a standard view of a microcomputer's facilities to software authors.

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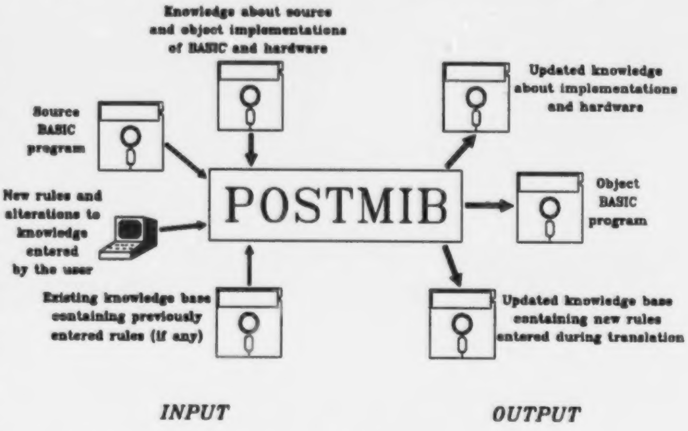
OVERVIEW OF THE POSTMIB SYSTEM

We have taken an IKBS approach to this problem. Our system, POSTMIB, is capable of being taught what to do as it progresses through the translation of a BASIC program. It has a knowledge of what BASIC programs look like and knows how to extract information from programs like variable names, strings of characters, etc. This knowledge can be utilised via the POSTMIB meta-language to deal with all the elements that go into translating a program. The idea is to computerise the translation process so that the human effort required by a hand translation (and hence the attendant cost) is substantially diminished.

Fig 1. Diagramatic Representation of POSTMIB Sytem


Knowledge about source and object implementations of BASIC and hardware
Source BASIC program
New rules and alterations to knowledge entered by the user
Existing knowledge base containing previously entered rules (if any)
POSTMIB
Updated knowledge about implementations and hardware
Object BASIC program
Updated knowledge base containing new rules entered during translation
INPUT
OUTPUT

The system is an integrated package that combines the tools required to undertake the task of translating a BASIC program. Figure 1 shows how POSTMIB deals with the storage and retrieval of knowledge.

Knowledge is given to POSTMIB in the form of rules written in a meta-language containing 54 commands.

A SIMPLE EXAMPLE OF THE TRANSLATION PROCESS

We will now look at a simple example BASIC program and convert this from BBC Microcomputer BASIC to GW BASIC. Our example BASIC program is shown below. It simply draws a square box with a random side length in the bottom left hand corner of the screen.

```
100 REM AN EXAMPLE BASIC PROGRAM IN BBC BASIC
200 MODE 2
300 W = RND(1)*100
400 MOVE 0,0
500 DRAW W,0
600 DRAW W,W
700 DRAW 0,W
800 DRAW 0,0
```

There are six different types of BASIC statement in this program and each type requires its own rule definition to specify how to translate it. Each such rule definition must be written by the POSTMIB user and is typed in only once: namely when POSTMIB first encounters a BASIC statement type that it does not already know. (Of course, if a previous system user had carried out some translation between this combination of source and object dialects, that knowledge will already be available to POSTMIB. Here we assume the translation begins ab initio). Once the rule definition corresponding to a given statement type has been entered, POSTMIB will use it to translate any statement of that type whenever it is encountered again during the current translation or any subsequent translations.

To make a start then, POSTMIB notices that in line 100 there is an unfamiliar statement. Since both the source and object BASIC dialects have a REM statement with exactly the same syntax, a rule definition representing a direct transposition is all that must be typed in by the user to teach POSTMIB to deal with source statements of this type. In fact, the user must type the following rule definition into POSTMIB:

```
; PROCEDURE FOR REM COMMAND                RESULTING STATE OF POSTMIB TRANSLATION

SKIP WORD("REM")
APPEND("REM  ")                            100 REM

; GET THE REST OF THE LINE
GET WORD(LINE,"")
APPEND(LINE)                               100 REM AN EXAMPLE PROGRAM IN BBC BASIC
```

In line 200 of the same program POSTMIB finds another unfamiliar statement. This statement is the MODE command which selects the type of screen format to be used by the BBC BASIC program. There is a screen selection command in the object BASIC but it needs to be complimented by further commands to fully emulate the MODE command of the source BBC BASIC. The user must type into POSTMIB the following rule definition:

```
; CODE FOR MODE COMMAND                  RESULTING STATE OF POSTMIB TRANSLATION

SKIP_WORD("MODE")

GET_NUMBER(MODE,10)

INITIALISE(FOUND,0)

IF EQUAL(MODE,1)
      INITIALISE(FOUND,1)
      APPEND("SCREEN 1:WIDTH 40:VIEW:CLS")
      INITIALISE(SCREEN,"TEXT")
      ADD_GLOBAL(SCREEN,SCREEN)
ENDIF

IF EQUAL(MODE,2)
  INITIALISE(FOUND,1)
   APPEND("SCREEN 1:WIDTH 40:VIEW:CLS") 200 SCREEN 1:WIDTH 40:VIEW:CLS
    INITIALISE(SCREEN,"TEXT")
  ADD_GLOBAL(SCREEN,SCREEN)
ENDIF

IF EQUAL(MODE,7)
  INITIALISE(FOUND,1)
  APPEND("SCREEN 0: WIDTH 40: CLS")
  INITIALISE(SCREEN,"TEXT")
  ADD_GLOBAL(SCREEN,SCREEN)
ENDIF
```

In line 300 POSTMIB encounters an assignment statement for the first time. In this case assignment statements have the same structure in both the source and object dialects of BASIC. But there is the possibility of an optional reserved word 'LET' that must be dealt with, as well as any unknown BASIC functions or BASIC variables used in the right-hand side of the assignment statement. Hence, the user will have to type the following rule definition into POSTMIB to describe the necessary translation:

```
; PROCEDURE FOR ASSIGNMENT STATEMENTS  RESULTING STATE OF POSTMIB TRANSLATION

SKIP_WORD("LET")

GET_VARIABLE(LHS)
APPEND(LHS)                            300 W

SKIP_WORD("=")
APPEND(" = ")                          300 W =

GET_EXPRESSION(RHS)
APPEND(RHS)                            300 W = RND*100
```

During the translation of line 300 using the above rule definition, POSTMIB will encounter the source BASIC function RND which is used to produce random numbers. At this point the translation must be suspended while the user types in a rule definition to tell POSTMIB how to translate the RND function. The syntax of the RND function differs slightly in the source and object versions of BASIC. The translation process must therefore produce a statement that is suitable for the object BASIC in that, there, RND takes no argument. Hence the following rule definition could be used:

```
; PROCEDURE FOR RND FUNCTION           RESULTING STATE OF POSTMIB TRANSLATION

SKIP_WORD("RND(")

GET_VARIABLE(R)

SKIP_WORD(")")

APPEND("RND")                          RND
```

POSTMIB is capable of dealing with numbers and mathematical symbols that may be used in assignment statements without further information and so the remainder of this line will be dealt with automatically.

In line 400 of the source program there is a graphics MOVE statement which moves the graphics cursor to specified co-ordinates on the screen. There is no direct equivalent statement in the object dialect of BASIC and so a more complex object statement construction must be produced to simulate the action of the MOVE statement. This is done using the LINE statement of the object BASIC which draws a single dot on the screen at the co-ordinates specified but in the colour already displayed at that point. By the definition of LINE in the object BASIC, further graphic commands will go from the position reached in the last LINE statement and so this LINE can be used effectively to perform the move. The only complication is that the graphics co-ordinate system is different in the two BASICs and so there must be a translation of the screen co-ordinates used in this command. In fact BBC BASIC (X,Y) corresponds to GW BASIC (X*0.2494,199-Y*0.1945). This can be taken care of by meta language commands that will do the translation automatically. Thus the user must type the following rule definition into POSTMIB:

```
; PROCEDURE FOR MOVE COMMAND              RESULTING STATE OF POSTMIB TRANSLATION

SKIP_WORD("MOVE")
APPEND("LINE  ")                          400 LINE

GET_EXPRESSION(X)
TRANS_X(X)
APPEND(" (",X)                            400 LINE (0

SKIP_WORD(",")

GET_EXPRESSION(Y)
TRANS_Y(Y)
APPEND(",",Y,")")                         400 LINE (0,199)

APPEND(" - LINE (",X,",",Y,")")           400 LINE (0,199) - LINE (0,199)
APPEND(",POINT  (",X,",",Y,")")           400 LINE (0,199) - LINE (0,199),POINT (0,199)
```

In line 500 of the source BASIC program POSTMIB meets the first graphics DRAW statement which draws lines or dots on the screen. The object dialect of BASIC has a line drawing command which also draws line or dots but it has a different format from that of the source BASIC. This must be taken into account by the rule definition as must the translation of the screen co-ordinates used. Hence the user must type the following rule definition into POSTMIB:

```
; PROCEDURE FOR DRAW COMMAND              RESULTING STATE OF POSTMIB TRANSLATION

SKIP_WORD("DRAW")
APPEND("LINE - ")                         500 LINE -

GET_EXPRESSION(X)
TRANS_X(X)
APPEND(" (",X)                            500 LINE - (INT((W)*0.2494+.5)

SKIP_WORD(",")

GET_EXPRESSION(Y)
TRANS_Y(Y)
APPEND(",",Y,")")                         500 LINE - (INT((W)*0.2494+.5),199
```

Lines 600, 700 and 800 of the source program also contain the DRAW command and since POSTMIB has now been taught what should be done to translate this type of BASIC command, the remainder of the translation can take place automatically.

Using the above rule definitions, our example source program is translated by POSTMIB into the following object program:

```
100 REM AN EXAMPLE BASIC PROGRAM
200 SCREEN 1: WIDTH 40: VIEW: CLS
300 W = RND*100
400 LINE (0,199) - (0,199), POINT(0,199)
500 LINE - (INT((W)*0.2494+.5),199)
600 LINE - (INT((W)*0.2494+.5),INT((199-(W)*0.1945)+.5))
700 LINE - (0,INT((199-(W)*0.1945)+.5))
800 LINE - (0,199)
```

CONCLUSIONS

POSTMIB has been proved to be effective in translating an actual educational software package from BBC BASIC to GW BASIC. Certainly it is not a tool for novices, but the professional should find that it removes the first, time consuming, job of translating the major part of the program. There may of course be parts of the object program that need further tidying up or altering if they are not 100% correct, but the process should have been simplified.

We should also note that POSTMIB is a general purpose translation tool that can be used for any combination of source and object BASIC dialects. This means that once the knowledge has been built up for a particular combination of dialects that knowledge can be used again and again for translation purposes. Also, because of this general approach POSTMIB can be used to translate between other versions of other programming languages, so long as the correct rule definitions can be entered to deal with the particular translation required.

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PLANNING FOR THE FUTURE
SYNERGETIC DOCUMENTATION OF EDUCATIONAL EXPERIENCES
THE MISSING LINK IN MEASUREMENT

Margaret Langlois

The specification of knowledges, skills and competencies a student should possess at various educational levels is currently documented in schools in terms of subject area, grade, and test scores. Test scores have become primary criteria for judging the work of pupils and providing a gauge for classification, diagnosis, promotion, graduation, and selection. They are basic ingredients of educational research where a primary concern is the discovery of causal relationships.

Over the past decade educators and researchers have developed a greater understanding of what intelligence is and how learning takes place; a better comprehension of learning processes; more ways of discriminating between learning styles and coordinating instructional methods. Opportunities abound for improving other variables such as curriculum interaction, congruence, delivery of instruction, instructional materials, and environmental support. Paradoxically, all these produce a greater dilemma.

It is well known that measurement of different abilities, documentation of educational experiences and/or assessement of knowledges and acquisition of skills goes far beyond the number of right scores on a standardized test. Powerful but subtle pressures continue from political and educational groups for retention of the status quo. Experts, entrenched in particular styles and comfortable with the instruments they have produced, have, as their major thrust, the improvement of already existing products.

This is an age when information is power. Superior authority and superior knowledge are no longer synonymous. Knowledge may come from anyone anywhere. The quality of knowledge is more important than its origins. Skills change with experience, training and practice. The structure of intelligence may vary as people learn and circumstances are altered. A person is not isolated but is in constant interaction with the environment. All of these findings have impacted on educational philosophy.

With the addition of multiple and separate centers of learning from home-based TV/video, travel, hobby experiences, apprenticeships, neighborhood tutoring centers; camps and summer workshops; community organized group meetings and classes, and offerings of public institutions (i.e., libraries' media departments), opportunities for all kinds of education have been extended and will continue all through life. Learning and learning experiences going on outside school walls will continue to increase significantly. Distance learning is already operational with knowledge from far away places coming to students. In a broader context, technological achievements, a national educational policy of 'return to the basics', the setting of new standards, and critical historical events have forced educators to face up to the need to revise the record keeping process, make it more flexible, adaptable and allow for changes in mode, method, sequence, substitution, location, and scope.

Today the predicted revolution in education through technology is underway. While the main focus is on curriculum and the delivery of instruction, a very crucial link is missing.--- the link that would make possible the delivery, categorizing, and documenting of all kinds of educational experience in a way that data could be retrieved and used for evaluation of a pupil at any time.

The prime objective of this proposal is the development of an automated system to account for documenting achievements, competencies and/or skills in: (1) a subject area; (2) with parameters denoting scope, depth, and significance; (3) having 'easy' update capability; (4) gathered on a standardized form; (5) accommodating levels, types, modes, and places. The data can be reported via a variety of clear, comprehensible formats and later summarized and analyzed.

Work on documenting educational experiences has been underway since the late '70s. At that time a system was designed that would consist of four interactive files. The last of these files, "The Missing Link", (#4) would be used for the documentation of educational achievements, experiences, and competencies. Among the coded elements included are: (a) categorization of material learned; (b) place-state, city, county, building; (c) subject-area, scope, content; (d) auspices-public, private, voluntary, national; (e) level-elementary, secondary, post-secondary, professional; (f) description of process-classroom, small group, indiv. tutoring, self-taught, media; (g) method of assessment-formal testing, informal, checklist, in-basket, observation, certification.

Many efforts were made to find funding. Perhaps because the work was not packaged in style, or more background was needed to make the leap, or simply there was just normal resistance against change, there has been no great rush to support the effort. A natural resource seemed to be ETS which has a tremendous system in operation for their College Board examinations. ETS has a coding system, an excellent retrieval system and many other elements for transfer of data and networking.

As work on on the "Missing Link" continued, it became obvious that what was really needed was a large agency/company and expert staff. At the same time, many of the well-known publishing/software/ hardware companies were developing a variety of automated integrated administrative systems for education.

Different systems had different components and different strengths. Familiarity with Schoolmaster (Olympia Computing Co., Inc. published by CTB-McGraw Hill) resulted in its being chosen as an example of a system which could be expanded to include "The Missing Link". It should be understood that this commercial system is being used as an example for purposes of this paper; that there are many other comparable systems; and that no inspection, comparison, or analysis has been conducted on any large sample of products currently on the market.

Schoolmaster is one totally integrated student administrative software system consisting of a student database plus three other components: student scheduling; attendance/intervention; and grade reporting/schedule maintenance/transcripts.

The individual database, is the heart of the system upon which all other modules are dependent. It features a name search and retrieval system with input screens for up to 900 fields of information in addition to those on the standard data-entry screens. It is menu-driven, with networking capabilities, and pop-up windows allow the user to recall information from any component. Data can be entered, reviewed, added, changed through data entry screens.

In addition to the four components, there are opportunities to create user-defined screens. They are for viewing rather than for data collection. This is one limitation. The second, more important, is that the system has been designed for schools, and school districts. Whether it could be expanded for state or national use is open to question.

If such an automated system for documenting achievements, competencies, experiences and/or skills were to be feasible using a commercial product, a separate component would need to be planned with the idea that it could be integrated into the master system. With such a sophisticated system, the addition of another component would not be as formidible a task as with systems less "user friendly", with more limited range and capability. In additon CTB- McGraw Hill, known for standardized tests, has TESTMATE, a system that enables a local school system to scan, score, and report test data from norm-referenced as well as from criterion-referenced tests; a TEST BUILDER which generates locally created criterion referenced tests; a DATA WAREHOUSE ITEM BANK, which not only provides the capability for creating customized tests to measure local curricula but also can be used in conjunction with standardized norm referenced tests.

The use of computers for educational tasks has demanded that all elements of a task or activity be carefully specified unlike methods used when administrative work was done manually or semi-automatically. In order to assure standard coding a national 'occupational' or 'instructional' research program would need to be initiated from within the Department of Education.

In the mid-1930's, the need for a type of occupational descriptive information was recognized and a Federal system was established. From this came the Dictionary of Occupational Titles, a comprehensive body of standardized occupational information for purposes of job placement, employment counseling and occupational and career guidance. Such a body of information is long overdue for education. With the increasing use of the computer and opportunities to partake of a multitude of educational experiences extending all through life, a comprehensive body of standardized educational information is a necessary priority.

In a recent NYTimes "Education Life" article, Peter Lewis quoted David Grady, editor and publisher of the Grady Report on Personal Computers in American Education: "I hope we'll come to see that a level playing field in school equipment and connectedness is, in fact, in the national interest and will happen only with national consensus and commitment." because technology is clearly limited by national rather than by technical expertise, he likened the goal of making schools a part of an emerging national data system to the establishment of the Tennessee Valley Authority Rural Electrification Administration. Until such an effort is made the link between curriculum/instruction and the documentation of educational experiences - in school and out - will remain 'MISSING'.

A handout will be distributed to show the major elements of information necessary for documentation of educational experiences, the elements of a standard code, and the method by which captured data can be converted into subject area grade marks for credit or certification.

TESTAID, AN ITEMBANK AND TEST DEVELOPMENT SYSTEM

Hans Feenstra*

ABSTRACT

TESTAID is: 1) an information processing tool to support more effective measurement with maintenance of test item data bases with all of the item attributes needed; 2) a test generation tool to quickly, easily and systematically construct measurement instruments with effectively carry out the intended measurement purpose; and 3) a test processing tool for efficient capture, storage and manipulation of data for the administration of tests and test results.

INTRODUCTION

The Institute for Educational Measurement (Dutch acronym: Cito) has developed TESTAID, a micro-computer based test construction system using several item banks. The general mission of Cito, a non profit semi-governmental organization, is to improve assessment as well as evaluation processes and procedures in education. Cito fulfills this mission by developing and publishing educational test and test materials (items) for many subject areas in primary and secondary education. In this paper the functions and implications of TESTAID will be described. The benefits of TESTAID to teachers is to employ a qualitative better and more efficient educational assessment system. By using TESTAID teachers can get access to professionally constructed items and tests. These benefits are made possible by advancing computer hardware; micro-computers (IBM PC and compatible); powerful software and tools providing simpler user-interfaces. The widespread incorporation of the micro-computer into the schools at secondary level in the last four years, as a result of the Dutch New Information Technology in Secondary Education project (NIVO-project)[1] has had a dramatic effect on the context of a itembank and test development system. It is now possible to incorporate the computer into the on going educational process in a manner that is both technologically and economically feasible. Because of this, there is widespread interest in the role of an item bank and test development system.

AIMS

With TESTAID teachers can get access to higher quality test items; teachers wanted to use the objectives and items from Cito, because establishing objectives and constructing items was a difficult and time-consuming process.

Teachers can use these items to construct tests which give results that have higher validity and reliability with respect to the intended measurement purpose.

Teachers can obtain more meaningful and useful reports of the results of testing more quickly.

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PURPOSE AND IMPLICATIONS

The purpose of computer-based test item banking is to support the management of the test item development process. An item is written to

measure an objective in the curriculum. The data base of a test item bank should include, in addition to test items and their attributes, a curriculum taxonomy which is used to classify the test items according to the particular part of the curriculum that they measure. One part of this taxonomy is information of the learning content structure as basis for the itembank, additionally a second part, the behavioral category (e.g. learning level in Bloom's taxonomy) can be specified. be specified.

The basic reason for developing an item bank is to facilitate and speed up test construction. However test construction stills requires some level of expertise and enough time. It is necessary to develop a test definition, to specify the topics (objectives) and other parameters used to select the items, to extract the items and to determine if they actually could be used for the purpose at hand. Either, the advantage of TESTAID is that teachers can develop their own tests (school-tailored) and based on their specific instructional process. Teachers are very hard pressed for time. They teach many classes and have limited time in and out of class. In order to get them to employ computer aided test construction, it must be shown that it reduces there work load. There is no need for item construction, item banks are developed for several subjects and on different levels by Cito. There is a large advantage dealing with test scoring and reporting of results.

SYSTEM DESCRIPTION

To discuss the system, it has been broken down into three modules: test item banking; test generation and test processing (scoring and reporting).

Itembanking

The main input for TESTAID is a school itembank. A school itembank is a set of items specially constructed by Cito for use by teachers. These items deal with one of the school subjects and are intended for use in one school type (vocational/ non vocational; primary/ secondary) and/ or grade. Apart from professionally constructed items, these itembanks also contain information about the learning content structure as basis for the itembank. Items in an itembank are necessarily structured by the learning content; the learning content structure of an itembank forms the connection between the learning content, the curriculum and the tests. A suitable structure should meet the following criteria:

- the structure should be an adequate description of the learning content;
- the structure should be a framework through which items van be classified and retrieved;
- it should be possible to specify a test by means of the characteristics of the structure.

TESTAID is a central school information system which can manage several different itembanks. The school itembank should contain all the items that a user may need during construction of a particular test. Users of TESTAID (teachers) can enter their own items into the structure to adopt the test to their own learning content, and to alter existing items. The main characteristics of TESTAID are determined by the number of items that a school item bank contains. It is estimated that up to 700 items

are necessary for a bank to cover one grade and that teachers will have the possibility to add a maximum of 200 school items. The maximum number of items in one itembank is 1500. TESTAID can support 30 itembanks within one micro-computer system.
The following attributes must be assigned to a test item:

- item identification code - a unique number;
- item text - questions can be entered using the power and flexibility of the built-in editor. This editor provides all the functions of a traditional word processor, including word wrap, a WYSIWYG interface, full-screen editing, insert and delete functions. It supports the IBM character-set with super- and sub-script possibilities (no mathematical or scientific characters).
- item type - TESTAID uses two types of test items: multiple choice and open-ended questions (the student is asked to write an answer to the item; this product is observed and rated based on some preset criteria).
- correct answer - correct answer selection in case of a multiple choice question or in case of an open-ended question the criteria which should be used to judge the student's response including the maximum score
- curriculum classification - the relation of the item with one or two levels within the learning content structure (or objectives).

The following attributes are optional and can be assigned to a test item:

- level of learning (behavioral category) - the item can be labeled according to a particular classification or hierarchy of learning, e.g. the taxonomy of learning developed by Bloom.
- difficulty - a judgement regarding the difficulty of the item (can be based on psychometric parameters)
- target group
- reference or context material - the item may require a special text passage or a graphic. This text or graphic may be related to several test items.
- cluster item identification - a cluster of items that belong together; this cluster has an identification and each item has a place number within the cluster.
- status - stage of development; an item which is still in a stage of development cannot be selected for a test.
- item exclusion - items which cannot be selected within one test can have an exclusion-identification.

Test construction: the test bank

Test construction is the main activity in the TESTAID-program. The learning content specification, as one of the main criteria, will provide a collection of items which can be included in the test. From this collection the items are selected which optimize the characteristics of the test. These characteristics are operational by indices such as target group, behavioral category; information function; difficulty; item type (MC or open-ended); scale values and item origin. The result of the test construction is stored in the test pool. Apart from a description of the test (items, order of items), this pool also contains the characteristics as mentioned above, the instructions for administering the test and for processing the results. On request a test (paper and pencil) in the test pool can be output in a form in which it can be administered. A master copy can be produced, and also directions for teachers with respect to the administration and correction of the test (answer key). Selection of items can be done in two ways: either using a random procedure or a manual selection where more item-attributes can be considered. The master test (ready for reproduction) is prepared by using a standard format, the test directions for the student can be added. Other documents, like selection criteria and information for test scoring can also be printed. Options for item numbers in the test, renumbering the items and sorting by item type and reference material will be provided.

Automatic test scoring and reporting.

When using the scoring component of TESTAID, a teacher can get the results of his/her students on the very same day the test is administered. The results of the students on item level are stored in the student databank. The results of the students can be entered by using a desk top scanner (optical mark reader) when students have marked their responses on a answer sheet or by keyboard data-entry. For open-ended questions, it is necessary for a knowledgeable person to assess the student's performance or to examine the product which the student creates. The assessment of the observer must then be read. This can also be done by using a scannable document on which the observer records his or her judgments or buy keyboard entry. TESTAID can score each item, subtest and test according to the scoring parameters, compute summary statistics, perform item analysis, and print a variety of reports. Report the performance of individual students and groups of students to the teacher and students. The results of the tests are provided in such a way that is useful for teachers in terms of making decisions (i.e. determination decisions). A total score for the test is obtained by the summation of the scores for all items on the test. These scores are raw scores. Using some transformation these raw scores can be interpreted by comparing them to some standard and school-marks can be calculated. This means that different scaling will be possible (variety of reports), and that the results will always be accompanied by an interpretative framework.

CONCLUSION.

The teacher is freed of many clerical tasks and will be able to devote more time to instruction-related tasks. There will be a distinct shift towards a more managerial role for the teacher. The availability of detailed reports of students results allows the teacher to assess the status and the progression of students in relation to both the curriculum plan and an instructional model. Testaid imposes a regulation of procedures, it demands teacher consultants and it necessitates a greater degree of systematization. The benefit of computer-based tools for test item banking, test construction and test scoring en reporting is to learn more on part of the achievement of students. There is a possibility that decisions involved in the educational process are supported by a new and more accurate information processing in a more timely fashion. The information is more accurate because tests are generated using professionally constructed item of Cito (authors with experience and expertise in writing items). The analysis reports give more specific information of student performance, both individually and as a group.

In the next three/four years Cito will develop item banks with high quality test items for all subjects on secondary school level. Users of TESTAID are supported by a service system, 24-hour phone-service; in-service training; technical support; workshop's and summer-school courses. TESTAID is very simple to use because it is designed to provide simplicity in the user interface. Although there are many features and functions of an ideal system, many users can benefit from the most basic functions at the outset and grow to fuller use of the broader functions as time goes by and experience develops.

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[1] The NIVO-project constitutes a joint effort between the state, industry and education organizations to give a strongly impulse to information technology in lower vocational and general secondary education in the Netherlands. The project provides in a coherent approach of in-service training, hardware provision and software development.

COMPUTER ASSISTED LEARNING THROUGH TECHNOLOGY BASED CLASSROOM FORMATIVE EVALUATION: AN APPLICATION OF INFORMATION REFERENCED TESTING

James E. Bruno*, James B. Baxter**

ABSTRACT

The purpose of this paper is to present research findings of an experiment involving computer assisted classroom learning through technology based formative evaluation. Formative evaluation, using a computer assisted Information Referenced Testing (IRT) format is examined in the context of how technology can be used to assist and promote learning in an inner city elementary school classroom.

INTRODUCTION

In the United States research on successful schools has produced a large body of information known as the "effective schools" literature. These findings indicate that effective schools are characterized as having a strong emphasis on pupil acquisition of skills as well as the careful and frequent evaluation of pupil progress. In essence, the central thesis of the effective schools literature is "that some means must exist in the school by which the principal and the teachers remain constantly aware of pupil progress in relationship to instructional objectives" (Edmonds, 1981). IRT is specifically designed to provide this type of educational feedback to both the student and to the teachers in the instructional program.

These mass assessment needs have also stimulated research into computer based methods for extracting higher quality information from these assessments for purposes of instructional leadership and more importantly formative evaluation (evaluation of individual student learning). Computer assisted learning one-on-one (student with terminal) while an educationally valuable tool, is still extraordinarily expensive and not economically viable for most school organizations. Engineering computer assisted learning into educational settings, where the computer is used like a medical laboratory or "service" center, therefore remains a major challenge for educational policy makers.

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OVERVIEW OF PRESENTATION

IRT is an assessment concept that uses a modified confidence weighted-admissible probability measurement (MCW-APM) type of test scoring procedure instead of a simple right-wrong (R-W) procedure to assess student performance. IRT permits and encourages students to admit their actual information states (I am sure, I am not sure, I don't know). It also awards partial credit for partial information and assesses no penalty when a student admits to a lack information, thereby reducing the need of students to guess. With IRT, student attainment is referenced to an information based standard of mastery. These standards are informed, partially informed, uninformed, and misinformed. The main use of IRT in computer assisted learning is to generate detailed information referenced feedback to the student in the form of an individual education plan (IEP). Instructional cross-references and corrective exercises to address specific information needs of the student are provided in the IEP. Clustering IEP information across students generates feedback to the instructional program. This information can be then be used to articulate to parents, teachers, administrators and curriculum specialists weaknesses and strengths of the overall instructional program.

By utilizing the vast information processing capabilities of the technologies associated with computer assisted learning such as optical scanners, PC type computers and high speed printers, IRT is able to produce a detailed audit of the instructional program and to effectively monitor each student's progress. This low cost economically viable procedure also permits teachers and administrators to assess each student's instructional needs and enhance the overall formative evaluation process at the school site.

In this presentation the research findings and reactions of students and teachers to the IRT procedure are discussed and examples of the various IRT reports and analyses presented. The IRT procedure is suited to large, urban, inner city classrooms and is especially valuable for formative evaluation. For many of the students in these urban settings the classroom is the single source of accurate, reliable information in the basic skill areas of language and math. The weak educational home support environment of many of these students cannot be depended upon to assist classroom teachers with the instructional program.

Recent applications of the IRT procedure to other areas of the instruction program such as the design of inservice programs for teachers and curriculum articulation to feeder schools are also discussed.

THE CASE FOR COMPUTERIZED INSTRUCTIONAL MANAGEMENT

Copyright Educational Technology magazine

Karen Condon*

ABSTRACT

Measurement of individual student academic achievement is integral to the implementation of any instructional model.

The computer can be a valuable tool to:

* Manage the information associated with keeping track of individual student progress.

* Diagnose and prescribe information needed to meet individual needs.

* Group students for more efficient direct instruction.

However, a computerized instructional management system is only a tool for the management of information and is not a substitute for effective teaching. The school must carefully separate those functions best performed by CMI from those that may be performed only by human beings.

INTRODUCTION

Over the past 20 years, a number of educational philosophies have developed, all of which have a common goal and a number of common characteristics. The goal is increased student achievement. The common characteristics are: 1) a belief that all students can learn, 2) emphasis on continuous (formative, not summative) monitoring of student progress, 3) immediate feedback, 4) well-defined and sequenced learning objectives, 5) emphasis on criterion-referenced tests as an assessment tool rather than norm-referenced tests. These five characteristics may be identified as critical to Benjamin Bloom's Learning for Mastery Model, Madeline Hunter's Model for Effective Instruction, Ronald Edmonds' Correlates of School Effectiveness, and any of the forms of the Outcomes Based Education movement.

Based on current research, there is little doubt that the implementation of any of these programs which emphasize learning for mastery has a positive impact on student achievement. In a synthesis of research on group-based applications of mastery learning, Thomas R. Guskey and Sally Gates concluded, "we found that group-based applications of mastery learning have consistently positive effects on a broad range of student learning outcomes, including student achievement, retention of learned material, involvement in learning activities, and student effect."[1]

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MANAGING INFORMATION

The implementation of any of these instructional models requires some sort of information management system. The need to plan instruction based on student progress, diagnose and prescribe to meet individual student needs, and to group for more efficient direct instruction requires that there be ready access to student progress information, instructional resources, and most importantly the curriculum. The manual record keeping tasks associated with the implementation of such programs can be discouraging and sometimes overwhelming. Instead of planning instruction for students, the teacher is busily filling in charts and attempting to make some sense of the data that he or she must maintain. In the meantime, students continue to move on or flounder, and the data, which have been so meticulously kept, are quickly out of date.

The computer is an ideal tool for making the record keeping tasks associated with instructional management more efficient and helpful. Its memory allows it to produce almost instantly a list of materials which may be used to teach or reteach a skill--not only those most commonly used, but those appropriate for a 6th grade student with a 2nd grade reading ability or for a 2nd grade student with a 6th grade reading ability. It can make readily available to the social studies teacher the reading abilities of his or her students so that appropriate content area materials may be selected. It can insure that not even a quiet, well-behaved student will "fall through the cracks."

The computer's ability to score and report the results of certain kinds of tests can save teachers considerable time that may be better used. For example, teachers can use the extra time to assess student progress on those skills that are not so easily measured with paper and pencil, multiple-choice tests. Its ability to manipulate and organize this data allows it to group students and produce immediate feedback to students and teachers at the stroke of a key. In short, it makes continuously monitoring student progress on all skills a viable option.

Using the computer, the teacher can assess student retention of the skills taught and disaggregate assessment data to determine the effectiveness of the instructional program for all students. With the computer's ability to communicate with other computers, the effects of student mobility can be alleviated by providing immediate access to student progress information and minimize interruption of instruction. This ability to communicate gives the district access to data to assess the total instructional program, the effectiveness of specific programs, and to plan district-wide in-service programs. If, as Ron Edmonds and Larry Lezotte wrote, "One of the characteristics of effective schools is that no program or activity is continued that does not advance pupil progress on standardized measures of achievement,"[2] then the availability of that data is critical.

COMPUTER AN IDEAL TOOL

As early as the late '60s, a few educators saw that the computer was the ideal tool for managing the tremendous amount of information necessary to implement a program in which mastery by all students, regardless of race, economic status, learning style, or perceived ability, was the goal.

Yet today, despite the introduction of the microcomputer and the emphasis on technology in education, few school districts have taken advantage of their computer resources to manage their instructional program. The reasons for this vary. In some instances, the reasons have nothing to do with technology, but rather with curriculum, economics, and personnel issues. In some cases, it may simply be rebellion from the position that says technology is the tool by which we shall attain both excellence and equity in education. This position is based on the notion that computer-managed instruction (CMI) will raise test scores and insure that all children will have an equal opportunity to excel.

Although computerized instructional management is not a panacea, it does hold great promise as one of many tools to achieve those goals. However, it is the attitudes and skills of the people using those tools that will determine whether or not those goals are achieved. If the teacher believes that Johnny's home environment precludes his success in school, CMI will not save him. And if a teacher cannot keep 25 to 30 students working productively at different tasks, the individualized prescriptions that spew forth from a computer will be useless.

AREAS OF CONCERN

If it is generally agreed upon that technology and CMI--while not the total solution--can certainly provide tools to help solve the problems that have existed for the past 20-odd years, then what are real reasons for the hesitancy to embrace CMI?

* Teacher Evaluation: The concern raised by teachers in districts considering the adoption of a CMI system is that the system will somehow be used to evaluate them. Most educators recognize that test scores are only one measure of a student's accomplishment in school, but they do not provide the total picture. Some teachers fear that computers will make it easier to evaluate them negatively if their students don't do well on computer-scored test.

* Training/In-Service: Many teachers simply feel inadequately prepared to use computers. In a study by C.E. Robinson and N. Protheroe, teachers rate developing computer skills as their most significant training need.

* Economic Issues: Often CMI is just not seen as a necessity. Therefore, it is difficult to justify the expense--not only for hardware and software, but for the resulting changes in the instructional process.

* Curricular Issues: There is concern among many that CMI will dictate the instructional program, that teaching by objective--implied if not stated in mastery learning programs--means the neglect of the higher level thinking skills.

* Measurement of student progress: Will technology cause us to administer only the multiple-choice tests that are easily read by a test scoring machine and scored by a computer? Shall we teach what we test or test what we teach?

* Status of curriculum: Some schools have not implemented CMI because they feel their curriculum is not adequately defined and the tests to assess mastery of that curriculum have not been developed.

PEOPLE ARE KEY ELEMENTS

The response to many of these concerns depends on the school district and the people in it.

It is the district that must decide how to use the data gathered through a CMI system. Neither evaluation of teachers nor qualification for merit pay is the function of a CMI system, but rather its implementors.

Likewise, the CMI system will not determine whether a district accepts the measurement of only the lower level thinking skills as sufficient. Neither will it decide whether the district takes advantage of the time-saving aspect of CMI to administer more essay tests, and develop more creative means to assess the high level thinking skills.

While teacher in-service in the use of the computer has not caught up with the current need, it is not necessary to the implementation of CMI. The amount of knowledge required to operate a "turnkey" software package does not compare with that required to write computer programs. In the implementation of CMI by the Minneapolis Public Schools, part-time para-professionals were trained in the daily operational tasks associated with their CMI system, whereas teachers and principals were trained in using the data provided by the system.

The economic issues will be resolved when we view a CMI system as a necessity; as important to the functioning of a school as the secretary and the custodian. The advance of technology will continue to minimize the issues as it makes available more powerful computers for less money.

We must view technology and CMI as a means by which we better educate all students rather than a means by which we educate them at less cost. In its report, Transforming American Education: Reducing the Risk to the Nation, the National Task Force on Educational Technology stated, "Although our schools do serve many students reasonably well, our current and future society demands that we significantly reduce the number who now emerge from the system ill-prepared for productive, self-sufficient lives."[3] Perhaps we need to determine the costs versus benefits of our current approach. It is important to keep cost-effectiveness in perspective. Without effectiveness, the price will always be too high.

CMI ATTRIBUTES

Just as the implementation of CMI is dependent on the user, the benefits of CMI are dependent on the software package that is selected. Some desirable characteristics that must be present in a CMI system follow.

* 1) A CMI system must be able to reflect and support the school district's curriculum, testing program, and overall district philosophy. It should not dictate what is taught or tested.

* 2) The system must be capable of supporting any instructional model, ranging from individualized instruction to large group lectures.

* 3) The system must be building-based. It is the decisions that are made in the school building that have the most immediate and critical implications for individual students. Therefore, it is essential that principals and teachers have immediate access to the information required to make these decisions.

* 4) The system should also have the ability to provide useful data at the district level.

* 5) The system must be easy to use and should produce reports that are clear, concise and appropriate for a variety of audiences. Parents, principals, teachers, and curriculum supervisors have different information requirements.

* 6) There must be a commitment by the software vendor to continually expand the capability of the software as the sophistication of the users and the capabilities of technology increase. Without this commitment, the advances in technology will be wasted.

* 7) The system must handle with ease the continuous monitoring, testing, and re-testing of student progress. Students should not have to retake an entire test when they have failed to master a single skill.

* 8) Access to data on groups of students other than by class or grade must be available. The user should be able to easily produce testing reports for all bilingual students, mainstreamed students, or any other unique group within the school building. It is this sort of data that is essential in the evaluation of instructional programs.

* 9) The CMI system must truly save time and reduce record keeping. If teachers must manually fill in charts with data provided by the system or continually refer to a master list in order to interpret the objective codes printed on reports, the value of technology and CMI is lost.

* 10) The system must provide access to data which can be used for extensive item analysis. If decisions are being made about students' instructional programs, it is critical that the assessment of their progress is made with valid and reliable test items.

The remainder of the issues can be addressed only by the school district and its personnel. Careful planning and the involvement of all personnel who will be affected by the system is critical. Appropriate in-service for various users of the data is also essential. If principals and teachers do not know how to use the information provided by the system, the system serves no purpose.

ONE OF MANY TOOLS

Finally, the district must believe, and communicate to all personnel, that CMI is only one of many tools to be used toward achieving excellence and equity for all students. There are many things that it cannot do. A CMI system cannot, for example, evaluate student writing--nor should it. A measure of good writing is the ability to communicate ideas. Only another human being can assess that ability. School districts must carefully separate those functions best performed by CMI from those that may be performed only by human beings.

A CMI system that meets the criteria cited earlier provides a tool that will allow schools to do what they have been trying to do for the last two decades--meet the needs of individual students. At the same time, teachers are freed from clerical tasks and able to focus on instruction. Building principals have access to information that is critical to their role as the instructional leader of the school building.

The greatest benefit, however, is for the students. By knowing exactly where each student is, instructionally, at all times, teachers can prevent the frustration that occurs when a child is trying to master a skill for which the prerequisite skills have not been mastered. Appropriate instructional strategies and materials are easily identified, and appropriate placement of new students is done with minimal interruption of instruction. CMI offers an opportunity to do better than "serve many students reasonably well."

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GRAPHIC REPRESENTATION TECHNIQUES FOR INSTRUCTIONAL EVALUATION RESULTS

Makoto Takeya* **and Naoto Nakamura***

ABSTRACT

This paper presents an SS or Semantic Structure analysis method as a means for analyzing data taken from questionnaire rating scales. This method constructs a directed graph, called an SS graph, which represents hierarchical structuring of questionnaire items based on students' response data. This paper discusses the concept and fundamental theory of SS analysis method from the graphic point of view. Next, this paper shows an example of application of the SS analysis method to instructional evaluation. We have applied this method to (1) an instructional evaluation on our normal lectures on mathematics, (2) multi-media CAI courses on mathematics, (3) LL English courses, and so on.

INTRODUCTION

It is important to evaluate an instructor's teaching skills and lecture contents in order to improve teaching and to modify curriculum and instructional procedure. Test results and student ratings for instructional evaluation are useful for both his summative evaluation and daily evaluation. Student rating data mainly provide information on students' attitudes on teaching contents and skills,in comparison that test data mainly provide information on their comprehension level.

In order to analyze the structure of student attitudes, it is necessary to clarify the logical relationship in the set of questionnaire items on the basis of their actual response data. However,usual data analysis of questionnaire items relies on a mere comparison among individual item occurrence frequencies, i.e. a frequency table or a histogram on individual items. On the other hand, though multivariate analyses such as the factors analysis are often superior to univariate (frequency counts) analysis, it is difficult for us to interpret these analysis results.

SEMANTIC STRUCTURE ANALYSIS METHOD

For this purpose, first the authors present an SS (Semantic Structure) analysis method, as a means for a relational structuring method among various items on a questionnaire with rating scale[1],[2]. This method has been originally presented as a graphical analysis method for rating scale data. When the investigation results are shown graphically with respect to the items, we can observe the relational

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structure most clearly. This graphical representation is called an SS graph. The fundamental principle of the SS graph is shown in Table 1. This is composed of two models on student rating scores, arranged in the order of total rating scores. It is assumed that individual data in each model are obtained for five questionnaire items and ten students. Each item score consists of five options(rating scores),i.e. from 1(Strongly disagree) to 5(Strongly agree). In Table 1, as far as sequences of items and total scores of individual items are concerned,data structure of two models (a) and (b) are equivalent to each other.However,the ordering structure in each model is different from each other, as shown in Fig. 1. An arrow from I_j to I_k means that each student score for I_j is never less than his score for I_k. In Fig.1,model(a)and(b)represent one dimensional and two dimen-

Table 1 Models of rating score tables.

	Item					
	①	②	③	④	⑤	Total
1	5	5	5	4	4	23
2	5	5	4	4	4	22
3	5	4	4	4	3	20
4	5	4	4	3	3	19
5	5	4	3	3	2	17
6	4	3	2	2	2	14
7	4	3	2	2	1	12
8	3	2	2	2	1	10
9	3	2	2	1	1	9
10	3	2	1	1	1	8
Total	42	34	30	26	22	

(a)

	Item					
	①	②	③	④	⑤	Total
1	5	5	4	5	4	23
2	5	4	5	2	5	21
3	5	3	5	2	5	20
4	5	5	2	4	2	18
5	5	5	2	3	1	16
6	4	4	2	3	1	14
7	4	2	4	2	1	13
8	3	2	3	2	1	11
9	3	3	1	2	1	10
10	3	1	2	1	1	8
Total	42	34	30	26	22	

(b)

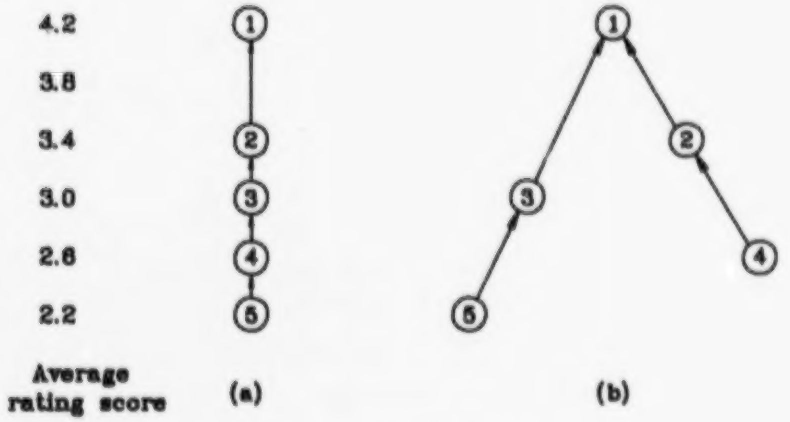

Fig.1 Models of the SS graphs corresponding to Table 1.

sional scale data structure, respectively.

Second, theoretical aspects on this structuring method are discussed. Denote the numbers of students and questionnaire items by N and n, respectively. It is assumed that each of the item is scored in 1,2,...,or m. Ordering relationship from item I_j to item I_k is logically considered that any student score for I_k is never less than corresponding student score for I_j. In a cross table between I_j and I_k, let N_{qr} denote the number of students who respond q for I_j and r for I_k. Then,it is theoretically considered that there exists perfect ordering from I_j to I_k,if and only if $N_{qr}=0(q>r)$. In general, however, it is rare to satisfy the perfect ordering condition. Therefore, the tolerance condition on ordering should be introduced in the form of the following ordering coefficient:

$$r_{jk}=1-\sum_{q>r}(q-r)N_{qr}/[N(m-1)].$$

Taking into consideration of this coefficient, following definition is introduced.

(1)There exists an ordering relationship $I_j \dashrightarrow I_k$, iff $r_{jk}>0.93$, otherwise $I_j \not\dashrightarrow I_k$.
(2)There exists ordering $I_j \longrightarrow I_k$,iff $I_j \dashrightarrow I_k$ and $I_k \not\dashrightarrow I_j$.
(3)There exists ordering $I_k \longrightarrow I_j$,iff $I_j \not\dashrightarrow I_k$ and $I_k \dashrightarrow I_j$.
(4)There exists equivalence $I_j \longleftrightarrow I_k$,iff $I_j \dashrightarrow I_k$ and $I_k \dashrightarrow I_j$.
(5)There exists no relation $I_j \not\longrightarrow I_k$,iff $I_j \not\dashrightarrow I_k$ and $I_k \not\dashrightarrow I_j$.

Though the proof is omitted, according to the above definition, all the items related to each other by the arrow can be arranged in the order of average rating scores. That is, the hierarchical structure of the SS graph can be easily constructed.

RESULTS AND DISCUSSION

We apply this method to several fields on instructional evaluation. That is,first is instructional evaluation on our normal lectures on mathematics, second is mathematics CAI courses using a multi-media CAI system and third is LL English courses. Fig.2 shows an example of an SS graph for instructional evaluation results. Detail study results are omitted the limited space.

In general,the SS graph provides us with a lot of information to evaluate the instructor's teaching skills and lecture contents. Last,the primary utilization points are introduced as follows:

(1)It is advisable to use the SS analysis together the factors analysis. We can analyze the relationship among a set of factors and relationship among individual items in each item set corresponding to each factor.
(2)It is useful to focus attention to a set of equivalent items and a sequence of ordered items. We can understand students' attitudes and behavior, based on the relationship among equivalent item-sets or ordered item sets.

As a result, we can obtain information on improvement in teaching methods and instructional materials.

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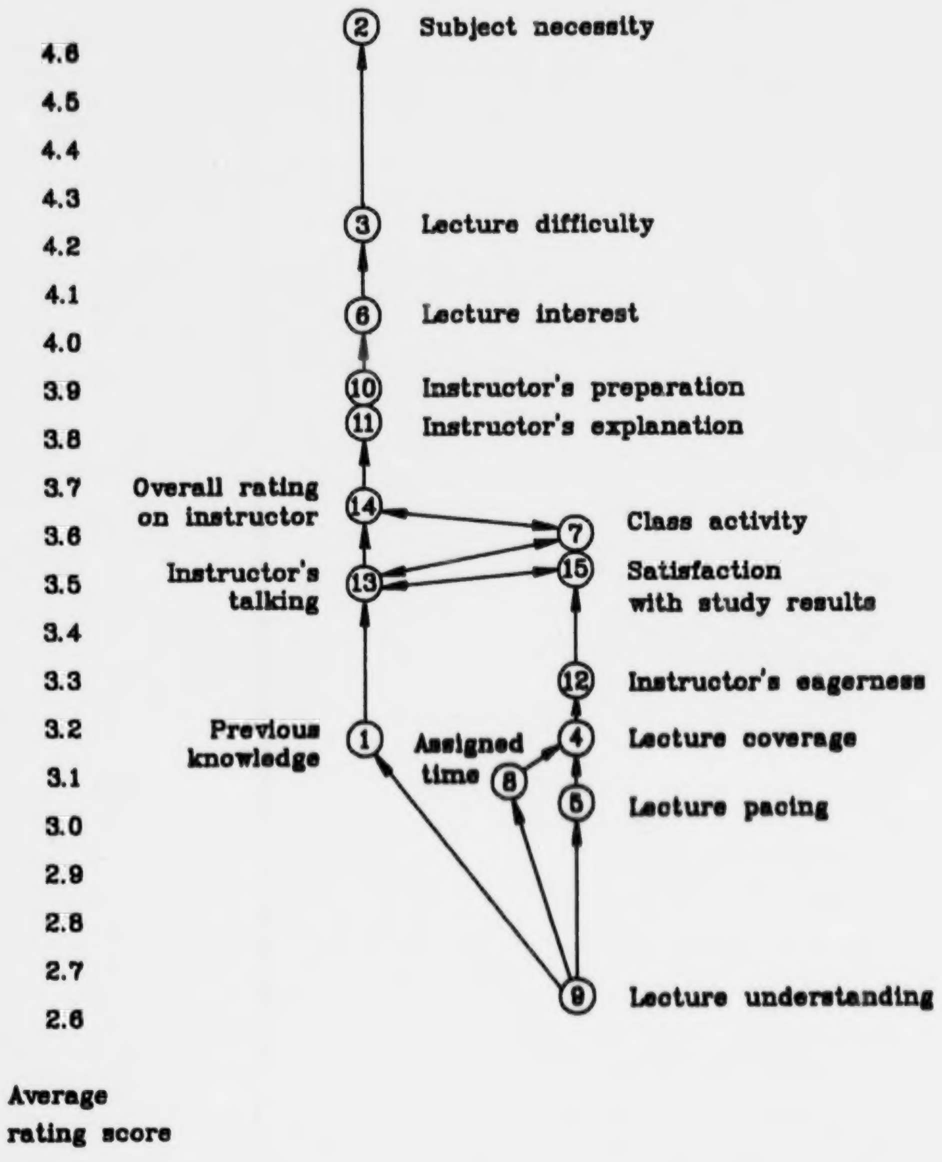
4.6
4.5
4.4
4.3
4.2
4.1
4.0
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3.0
2.9
2.8
2.7
2.6
Average rating score
② Subject necessity
③ Lecture difficulty
⑥ Lecture interest
⑩ Instructor's preparation
⑪ Instructor's explanation
⑭ Overall rating on instructor
⑦ Class activity
⑬ Instructor's talking
⑮ Satisfaction with study results
⑫ Instructor's eagerness
① Previous knowledge
④ Lecture coverage
⑧ Assigned time
⑤ Lecture pacing
⑨ Lecture understanding

Fig.2 An example of an SS graph for instructional evaluation.

Provoking, Supporting and Sustaining Classroom Change

J.F. Foster*

ABSTRACT

Children being brought up in the IT age need to be exposed to the new technologies. In spite of our best endeavours only a small proportion of teachers in England are as yet using the computer as a tool with their classes on a regular basis. They need to see a positive advantage in taking up new methods which may appear to make their work more difficult.

Combinations of in-service training, peer group pressure, pressure from society and the requirements of examination syllabi may cause teachers to change their practice. This has to be supported by suitable training, sufficient appropriate equipment, appropriate curriculum materials and technical and professional assistance if the changes are to be sustained. There must be a national will for these changes reflected, for example, in media cover and in the provision of adequate financial resources. Various strategies and case studies are examined.

INTRODUCTION

The children in our schools now have got to be sufficiently successful to earn enough, to pay enough tax, to enable government to pay me large welfare cheques, to keep me in my old age (which I intend should be long and comfortable). If they are to be this successful they will need every bit of help that their schools can give them. And one of the tools that will help this is information technology, put as the servant of the learners, across the curriculum, wherever it is appropriate.

We like to think in England that we are reasonably up with the pack when it comes to provision and implementation of a policy of IT across the curriculum. We had a national Microelectronics Education Programme from 1980 to 1986. This was succeeded by the establishment of the (less well funded) Microelectronics Education Support Unit (which after a year was merged with the Council for Educational Technology). We have had nationally subsidised hardware schemes, software schemes, schemes for promoting the use of peripherals, modems, turtles - you name it, we've done it. And yet the gurus tell us that only some 10% of the teacher population is comfortably using computers with their charges (and presumably within this 10% not all the practice is good?).

This paper is concerned with strategies that seem to be raising this percentage. But first I must consider why teachers are not rushing, lemming like, to embrace the new technologies. Insufficient kit, inadequate training, bad early experiences with trivial or difficult software, fear of exposing ignorance to experienced hobbyist children, misconceptions about the place of IT (the reaction to the panacea pushers) - all play some part in

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the reluctance of teachers. The resourcing argument is one of the most common and is often a too easy excuse though it has a significant part to play. However, we all know teachers who somehow through their enthusiasm have managed to annex money from all sorts of public and private sources, working the system to the benefit of their classes.

There is a precursor to in-service training in IT which encourages teachers to think about children as burgeoning autonomous learners, taking a greater part in their own learning. Learning needs to become individualised or at least less teacher centred. Children are different and need to be exposed to different ways of learning for them best to be able to attain our goals for them. If teachers think that they can teach a class satisfactorily in lock-step they are unlikely to warm towards teaching methods that support ways that are much more difficult to control, more difficult to prepare for and harder to check up on. They must first be convinced of the increased quality of learning and of motivation that can result from a change in methods. They also have to be satisfied that they will be able to manage them.

There is, as yet, very little objective evidence as to an improvement in the quality of the learning resulting from harnessing the seductive powers of the new technologies - though plenty of anecdotal evidence. And there are few ways to accelerate teacher confidence in their abilities to cope with the new.

SUPPORT

MESU (the Microelectronics Education Support Unit) has the task of trying to support and implement (and influence) government policy and, through the local education authorities and initial teacher training institutions, school and classroom practice. We try to spread and to promote good practice and as good educational technologists we start by looking at the problems we have to solve to do this. We are told:- there are not enough computers; there is not enough software (or anyway not enough of the *right* software); there is not enough training; teachers cannot see their role when children are using computers; programs are too complicated and full of computer jargon; there is no continuity of practice between grades, let alone between junior and secondary schools; there are too many changes going on........ etc., etc.

A school, a local education authority, a nation needs to have a policy and attitude towards the new technologies that can be clearly seen at least by those who are prepared to look. This produces the hidden curriculum for us all. New entrants to the profession must have been exposed to IT at their training college, not just in a couple of modules about computers and how they work, but where their presence is assumed wherever they have something to offer. There should be no "no go" areas. Hardware and human support must be readily available to the best standard that can be afforded and resourcing built firmly into forward budget plans (and this should be known about). In-service, wherever it is sensible, should be delivered by resource based methods including appropriate use of computers. Curriculum materials should reflect the hardware provision (it is a little off putting to have a textbook that presumes you have access to a laboratory full of computers when you actually only get your "turn" to use a single computer with your class on alternate Thursdays). Different programs should be operated in much the same way so that it is not a question of having to refer constantly to a "driver's handbook" when you take on a new piece of software. Help must be at hand.

We are blessed by a government that is rushing into educational change in every direction and change always gives us opportunities. More power is to be vested in a school's governors and in the headteacher and, at the same time there is being constructed a National Curriculum with attainment targets set and to be tested for. There is a clearly stated wish that information technology should feature wherever it is appropriate across the curriculum and at all ages and stages of development. There are to be five fat financial years for IT (we are just at the end of the first fat year). In this the local authorities have had some £19 million to spend on IT - eight and a half million on computers and ten and a half on "advisory teachers". These "ATs" (there are more than 600 of them) are an extra source of help at hand and a really effective resource in the management of change - and we have been able to engage their help in our Unit's mission.

The ATs have been recruited by the local education authorities (with funding guaranteed initially for two years) for their skills in the curriculum rather than specifically in IT. Their curriculum or phase expertise gives them some initial credibility in the group of schools they are assigned to. They have all had, so far, two weeks of intensive training from MESU. The first week has been concerned with their role as change managers; good practice at different stages of education and the importance of building on previous experiences; and generic IT. For this week they were deliberately mixed together at one of eighteen centres, but in the second week they were grouped with others from their curriculum or phase specialism and we concentrated on good practice in their particular interest in much greater depth. During the lead up period to these courses we had been commissioning special materials to be written for them, both to use for themselves, for the teachers they are having to try to influence and for the children in their classes. In the time available this has often just entailed collecting up existing materials and packaging them up to be more supportive. We got our first six video case studies made of practice - not particularly of *good* practice, but of practice that could start debate and where the best shown was in recognisable contexts, with teachers that they could identify with (not showing ultra small classes of highly self motivated middle class children being taught by exceptionally brilliant teachers with all the latest kit present in abundance).

The software issued was placed in curriculum context, often encrusted in curriculum materials that made no direct call on the computer. There were attempts made to help with the classroom management issues of having perhaps only one computer to 25 or so children, without artificial tasks given to children to keep down the queues at the computer. They shared their ideas with our staff and those who we had employed to help us (we had a 1:7 ratio of helpers to ATs), coping with the technical problems as they presented themselves in the ways that we hope they are now performing in the inservice roles they are now fulfilling.

We used every sort of teaching/learning strategy that seemed appropriate and tried to keep the straight didactic to a minimum.

We tried to promote local mutual support groups who would meet (or at least phone each other) during their employment as ATs (and beyond?) and we introduced them to our own information service which continues to support them with updates and free copies of our publications relevant to their needs. We also tried, but not always very well, to give them leads as to how they could move out from the comparatively secure base of their own curriculum or phase expertise into, for them, the uncharted waters of different curricula, abilities or phases. They will have been remarkably successful if they leave behind them a trail of written and agreed policy statements for their schools on the place of IT across the curriculum. They are all being got together again in the next few months.

While all this has been going on we have been trying to influence other developments: the choice and standardisation of hardware; the development of acceptable protocols for user-interfaces and program specification; moves towards software portability; the curriculum and attainment tests being considered for the National Curriculum; the development of new datalogging practice (and hardware, software and curriculum materials) - which will be fed out to the science AT specialists as part of the evaluation programme; government policies; interactive video etc.

Often our materials are developed with curriculum materials which the bright teacher will discard (and write their own) when they have gained in confidence but our policy is that teachers should NOT be having to write their own software, even with highly sophisticated authoring tools. This, like curriculum development itself, is a highly specialised branch of the profession and needs a team of experts in different aspects of curriculum and software design to be effective. We always try to make sure that the power of the computer is not wasted on trivia or on simulating experiences that should be experienced for real.

SUSTAINING CHANGE

We have real hope that our advisory teachers, sitting alongside classroom teachers will be a real instrument of change. They are after all an additional resource to what the schools and education authorities will be doing anyway in the way of cascade training and distance learning. But we know that the majority of these ATs will then return to their own classrooms, and though they will be brought out from time to time to help in in-service, their direct influence will be limited to their own schools. We must be sure that the changes they help to provoke are not wasted and that the process continues.

The new is especially seductive to some of us but too much of the new all at once palls the appetite. Always looking for new new things to do is also very waring. So we must ensure that teachers get continuing messages that what they are doing is worthwhile so that they continue and refine their practice. This means, amongst other things, that we have to be very much better, than at least we are in Britain, at getting the media to accept that educational success is news. We need to feel that we are part of a movement that is valued outside and inside the profession. We need to be given a say and a part in the development of new ideas and techniques, sharing ownership in what we are asked to do. We need to be praised a little.

HOW TO DESIGN EDUCATIONAL SOFTWARE - THE SWEDISH EXPERIENCE

BENGT BENGTSSON *

ABSTRACT

The basis for programming educational software produced by ~~the~~ Educational Software Group within the Ministry of a Education in Sweden consists of several intellectual tools and methods. Some of the ideas behind the programs have been born at courses in program design arranged by the Nordic Council for Education for teachers from the Scandinavian countries.

INTRODUCTION

Program design in Sweden is often associated with a special method for the working out of educational software. This paper describes the method in general terms, the contents of the courses and the performance. The Ministries of Education in Norway and Sweden have been arranging courses in program design since 1986 as a joint Scandinavian effort. The type of programs developed are often what we call lessonware. Lessonware can take many forms from programs for simple drill and practice to programs for training and simulation. The design method can of course also be used for the production of all kinds of educational software like, -general tools or open-ended programs that can be used for all educational fields, -subject-oriented tools aimed at vocational training, -subject-oriented tools for different school subjects, -courseware (a sequential number of lessonware).

THE COURSE

A particular goal is to give active teachers a possibility to use their subject knowledge and their pedagogical experience to influence the developing of good educational software. The teachers are primarily trained to become program-architects. They learn - a formal method to produce software for their activities in school, -to judge and evaluate what is good or bad pedagogical software, -how to work with and influence computer experts, -together with other teachers to collectively make pedagogical half-products (the systems analysis) for the programming staff, -datapedagogy and datamethodology. The courses are often given as 8 days courses in an internat with a steering committee consisting of a pedagogical leader, an administrative leader and several assistant teachers. Most of the work is done in workshops. The instructors work in pairs and are usually responsible for about three or four groups. The exterior form for the course is important as the participating teachers are exposed to a continuous, pedagogical process during the week.

THE METHOD - A SHORT OVERVIEW

The method emphasizes the students view of the program, the user-interface. During the course the computer itself plays a rather modest role. The working in groups and the underlying pedagogical ideas in the intended program are the essential parts. It is fruitful to mix different kinds of teachers in the same group. They don't all need to be subject experts. During this first stage they try to define the subject-area through

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curriculum analyses, from their experience as teachers and from subjects from real life. They try to choose parts of the curriculum that is normally difficult to learn, experiments that are dangerous to perform in the classroom and parts of the curriculum that the students consider boring or drudgery. They discuss the criteria for a model lesson, what kind of educational software they are going to develop, and how to combine the computer program with other teaching material. The more formal part of the method consists of certain steps that are successively introduced to the participants of the course. The instructors give the theoretical foundation and background when the group is ready for it.

In the next step they try to define the students point of view or more explicitly the time, the role and the place of the student in the program. The student can for example with the help of the computer speed up time, slow it down, go forward and back in time, stop and replay the lesson on the screen. The student can play the role of a fisherman or a king or a discoverer or a great author and he can be high above the surface of the earth, under the water or in a fishing boat in the Baltic. A piece of educational software where the student is himself, in the classroom, in real time has often very little pedagogical value.

The participants construct a responsibility table and distributes the responsibility between the student, the computer and the teacher. They have to use active verbs like create, choose etc to make the program interactive. A good measure of the value of the program is if the computer has to do all the dull, boring work and the students perform the creative actions.

Then the group tries to find a good metaphor (background or surrounding to the program). This metaphor will be the main user interface on the computer screen. They define all possible experience pictures that will appeal to the student and that will give him a chance to accumulate the knowledge achieved in the program.

When the teachers tried to put together all the preliminary ideas that they had assembled in the previous steps the usual flowchart didn't work to reflect the unity of the concept. Nor did a flow chart show relationships among the various subsections in the context of that overall unity. So we use a diagram "the market" to illustrate our thinking. The model was borrowed from Canada and adapted to our other development tools. The Ministry of Education in Ontario have used this design method to produce most of their educational software. The market-diagram is a graphical method to put together an overall view of the program that enables the student to find his own way through the program - a formal description of the underlying principles and examples. Just as a real market has booths where we choose to do things so does the market diagram have booths where the student or teacher makes decisions, selects something or generally does something.

The responsibility table described who did what. The booths are constructed with the help of the responsibility tables. The experience pictures are evaluated and placed in the middle of the market diagram.

The next step is the building up and design of the most important screen in the program "the key-screen" using text, graphics, color, animation etc. Within the Educational Software Group we have tried to standardize the components of the keyscreen, where the main learning is supposed to take place. At this stage of the work the teachers often amend their former work and redesign the market diagram for the program. The keyscreen is the base, the doing-place, a place for feed-back, a place for integration and good experience pictures, just like your ordinary black-board was before the computers arrived. In front of the keyscreen the student can for example select, point, move the cursor, enter data, choose commands and receive immediate feedback. The keyscreen summarizes, measures performance, attracts attention, sets atmosphere with color, integrates. admonishes, informs and offers options to the student. Important details of the keyscreen are the construction of menus and the commands available on the screen. This is done with the help of the market diagram and computerized design tools for prototyping.

When the keyscreen is ready the teachers list the commands used and write reactions- and conditions-tables for every command on the screen, explicit and implicit commands, make a graphical illustration with the help of designtools developed in Scandinavia. The most common tool for prototyping is named Mosaikk and is available for IBM-compatibles.

After that the teachers design different sequences and versions of the keyscreen that is, the teachers must define and design the full sequence of possible states of the key screen. Windows change, messages come and go, commands appear and disappear, values are updated, animation occurs and affects the appearance of the screen. When the keyscreen is constructed the work must be repeated for all the minor screens and the helpscreens. The participants follow the same procedures that were used for the keyscreen. For each minor screen and helpscreen the teachers must sketch a picture, prepare the screen sequence, prepare the list of commands, write condition tables and reaction tables. The market diagram is the basis for this work too.

Now the teachers have to identify the data and information necessary for the program and describe the files for the program in order to be able to produce user controlled animation and different kinds of graphs to accumulate and illustrate the knowledge achieved by the student. At last the teachers formulate and describe the algorithms and rules that make the program react in a realistic way or as we call it in Sweden "behave according to the laws of naive physics".

The teachers now have a chance to get their design translated into a computer program which is undertaken by joining a programmer to the group, converting the half product from the program-architects into a piece of good educational software. Within the Educational Software Group at The Ministry we evaluated authoring systems as a mean of coding the design. These tools are pedagogical application generators, 4GL-tools for teachers. They are menu-driven with a built in programming language and mainly consists of text editors, graphics editors, editors for animation and question-answer analysis. The authoring systems support interactive video, have a built in, standardized documentation, a CMI (Computer Managed Instruction) to keep track of the students performance, a WYSIWYG-effect (What You See Is What You get). All these functions make the authoring tools very useful as a prototyping tool and greatly reduces the time for coding.

advantages with authoring systems: - easy to use, - standardized documentation, -cost-effective
-portable (run-time-module), -easy to modify programs
-built in administration

Disadvantages with authoring systems: -license fee (for the run-time module), -isolated language -speed, -restricted file-handling, -producer dependent -hard to combine with general programming languages

After the coding and debugging of the programs follows the evaluation, production of teaching material, the marketing and distribution of the software. This is often done via private publishers. The teachers then have to make agreements to establish the legal formalities around the product.

THE EFFECTS OF THE DESIGN-COURSES

- the teachers attitude towards educational software is changed and deepened, - the teachers often get a more critical opinion of presently available educational software, - new demands on educational software and hardware, -they realize that they can actively take part in the production of good software for educational purposes, - they experience a pedagogical renewal and consider the course a very efficient way to learn and apply datamethodology, - they are confident as program-architects and producers of half-products to the computer-experts and publishers, - they put new demands on existing software. The main objective of the course is in fact to make the teachers realize the power of the computer as a new pedagogical tool and to encourage them to successively change their attitude towards the meaning of knowledge, the teacher's and the student's role, the organization of the school and a new aspect of epistomology. Several hundreds of Scandinavian teachers have been trained according to this method and a number of good programs for computer-assisted teaching have been developed during our project.

EVALUATION AND USE OF EDUCATIONAL SOFTWARE IN SCIENCE

D.L.Pratt*

ABSTRACT

To be beneficial, software development, use, and evaluation must take into consideration the subject matter as well as educational theory and practice. Much of the science software produced today cannot show how it improves science in learning in schools and is therefore not appropriate. The prevailing emphasis on drill-and-practice (D&P) and tutorial software does not show the most promise for use in science instruction. Tool software, however, such as spreadsheets, data bases, word processors, graphics, and desktop-publishing programs, lab interface devices, and simulation programs show more potential for improving science learning in many ways.

EDUCATIONAL PHILOSOPHY

In the short history of microcomputers, the selection and use of educational software has all too often been driven by the technology rather than by subject matter. The need exists to assess technological products in terms of their contribution to the learning process within a discipline. In science this has both subject matter and educational implications.

SCIENCE AS A DISCIPLINE

The study of science is not complete without engaging in the processes of data collection, processing and reporting data, and drawing conclusions from the data. Any type of device that helps one to collect or process data more rapidly, efficiently, or accurately is therefore a good candidate for use in the science classroom. Laboratory interface devices connected to computers belong in this category because they automate, speed-up, and allow data to be collected which would otherwise be impossible to collect. Also, simulation programs that expand or collapse time, elimate danger or other constraints show much promise (e.g. planetarium-type programs or *Operation Frog*). Finally, tools like spreadsheets, word processors, data bases, desktop publishers, and graphics programs are necessary in the presentation and calculation of data. All of these types of programs can provide students with tools for doing science. Of particular interest are the graphing programs that produce professional results but take away much of the drudgery associated with the pencil-and- paper method.

Computers can also enhance the learning of science in the general educational sense. They can enhance student learning by elevating the Bloom (1980) level of thinking and increasing personal control over the environment. Software can be used in a manner which recognizes differences in student abilities, interests, and predispositions to learning styles. The major works that have guided educational research and philosophy in the past could and should continue to guide the use of computers as an instructional tool.

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VARIED POINTS OF VIEW

Much of the educational world feels that the focus of educational software is too narrow. It concentrates too much on drill-and-practice (D&P) programs and lock-step tutorials which leaves little to the imagination and creativity (Pratt, 1988). Computer Assisted Instruction (CAI) has been identified by what McNeil (1985) calls the *technological* school of education. Emphasis is on behavioral objectives, frequent testing, and the deductive reduction of problems into small pieces. Software is designed to be a modern-day type of learning activity packet.

To be effective, software must also represent other educational philosophies as well. In addition to the *technological,* McNeil (1985) identifies the *academic, social reconstructionist,* and *humanistic* schools.

Academic practitioners emphasize the wisdom of the best minds in the discipline. Up-to-date and factual materials are of crucial concern, as are emphases on concerns associated with the discipline such as the process skills so necessary in science. For these reasons, the software program *What's in your lunch* would be valued because of its factual and carefully-researched nature. Similarly, any tool software (e.g. Science Toolkit, graphing programs) that facilitated experimentation would be regarded favorably.

Social reconstructionists, on the other hand, are much less concerned about a pre-determined format or content as they are about using instruction to better the conditions of impoverished and neglected groups. They favor software which reflect their concerns. Any type will do as long as it can aid in reaching the goal of improving society. Tool software that would help gather and present data for the cause would be especially useful. D&P exercises would be of little interest to this group.

Humanistic educators have similar goals to those of the *social reconstructionists* but with an emphasis on improving and developing the individual rather than underrepresented groups. Concern is for a whole person (opposite of the compartmentalization stressed by the *technologists),* integration of the self (knowledge and emotional state) and self actualization. Software selection for this group is almost entirely on an individually-prescribed basis. A piece of software which is good for one student because it motivates that student may do nothing for another student. This principle would apply to any software and is a good principle to use in general, regardless of educational preference.

Finally, Eisner (1983) identifies the *development of cognitive processes* school. This is the branch of education that advocates thinking skills and problem solving as the true basics. The argument is that society is changing toward the more complex at record speed and that ability to solve new and unusual problems is the most prized of all educational endeavors. *Cognitive processes* people would love *Rocky's Boots, Gertrude's Puzzles* and other logic programs. *Technological* and *Academic* educators, however, would be aghast at using such programs, wondering what value such content-free programs could possibly have.

The conclusion to be drawn from the preceding is that educational philosophy is diverse and that software itself should be diverse to meet all the players in the educational realm. A second point is that much of software selection and use is an individual matter, depending upon the philosophical bent of the teacher and the nature of the students. No single set of guidelines can be used by everyone.

UNIVERSAL PRINCIPLES

Certain more universal principles should also guide the use of software. Two of the most significant educational happenings of all times were Bloom (1980) and associates' mapping all of the educational objectives and Piaget's work with abstraction levels. The high significance of these advances in education in general should also be applied to software development and use.

As Bloom noted that education was too narrow in scope, software users should similarly be careful that all levels and types of learning is being addressed. Education was found to be focusing on level 1 of 6 levels of cognition and 1 of 3 domains of learning (cognitive, affective, and psychomotor), making it too narrow an experience. This type of myopia is as unacceptable with the computer as without. Actually, the computer is a natural for this integration. All levels of cognition can be in operation at once, programs can provide for psychomotor activities (typing, using a mouse), and affective goals can be met if using the computer is rewarding and pleasant.

Piaget's contribution was that schools present many ideas that are of such high levels of abstraction that it is impossible for many students to comprehend them without bringing the level of abstraction down. Content need not be "watered down", appropriate concrete experiences just need to be put in place so that students can cross over the void between the concrete and the abstract. Any software program that lowers the level of abstraction and does this has to be valuable on at least this criterion. Programs do this by using graphics and showing students the results of their inputs.

GENERAL SOFTWARE PRINCIPLES

The following chart of evaluation principles was synthesized from many sources (computer evaluation agencies and educational computing journals) and represents the author's presentation of a reduced list of the most cogent considerations. These principles should guide software selection:

User Friendly	It is easy to use
User Control	The user is in control; can branch and make his/her own choices
Documentation	The written materials are readable and valuable
Level of Difficulty	The level of difficulty is appropriate
Reinforcement Value	The right things are reinforced
Content	Students learn something worthwhile. *This is the most important criteria.*

TYPES OF SOFTWARE

It is also important to be able to identify software by type. Knowing the type suggests something about its purpose. D&P is used to drill with (as with electronic flash cards). Tutorials are used to teach the whole lesson as a stand-alone program. Simulations can represent some abstract event concretely and remove time, space, and safety constraints of the real world. Classroom management tools can help the teacher keep track of student progress, and tool software can be used to collect, analyze, and report data.

Drill and Practice	computer used for review (electronic flash cards); most common type; allows for practice
Tutorial	computer teaches the entire lesson; presents factual information
Simulation	computer represents a situation over which the user has control; considered to offer most promise in instructional software (examples: Oh, Deer; Volcanoes; Flight Simulator; Skylab; Voyage MIMI Ecosystems)
Classroom Management-	Programs that help teacher with tasks (spreadsheet, data base, word processor, and special grade programs)
Tool	Software that provides students/teachers with tools (Science Toolkit; lab interface devices; spreadsheets, data bases, word processors, graphic programs, desktop publishing)

TYPES FAVORED BY SCIENCE EDUCATORS

As is the case in other areas of education, the tool and simulation software offer many practical applications for the teaching of science. The tools make handling scientific data more manageable, and simulations reduce abstraction. Both allow for interesting and useful things to be done which would otherwise be impossible. In that sense, they make computer instruction superior to other forms of instruction. These two types of software possibly offer the greatest potential for the computerized science curriculum.

Tool software	extends lab instrumentation; allows for meaningful group work
Simulation software	eliminates time, space, and cost constraints

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EXPERIENCES ON EDUCATIONAL SOFTWARE AND DIDACTIC MATERIAL DEVELOPMENT IN MEXICO

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ANTECEDENTS OF LIBRO ELECTRONICO.

LIBRO ELECTRONICO S.A. was create in 1984 with the unique intention of develop educational products to be used in computer. The initial staff however started the project 1 year before, by these reason we consider us as pioneers in these technology. The main titles released to date are:

1985 SERIE COSMOS. (For Commodore 16/64)
Set of 8 lessons covering the main topics of mathematics secondary level.

1986 STATISTICS. (For APPLE IIe)
Lesson for high school level.

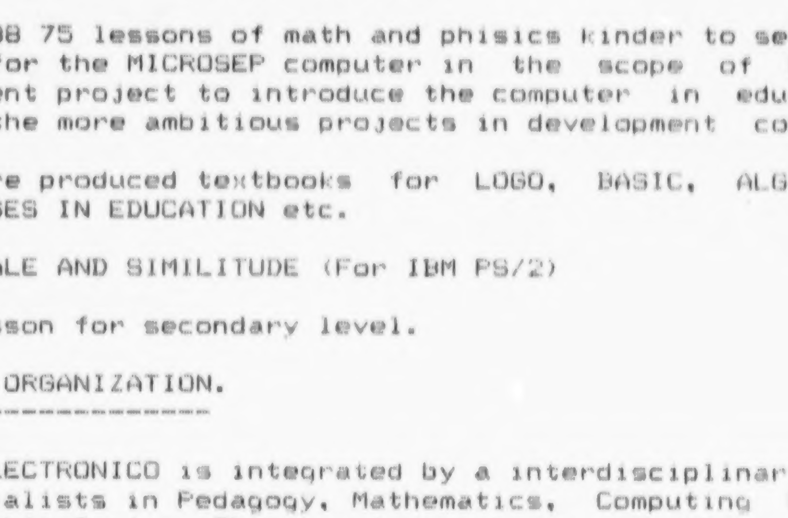
1986-1988 75 lessons of math and phisics kinder to secondary school for the MICROSEP computer in the scope of Mexican 3obernment project to introduce the computer in education, one of the more ambitious projects in development countries world.
Also were produced textbooks for LOGO, BASIC, ALGORITMS, DATA BASES IN EDUCATION etc.

1988 SCALE AND SIMILITUDE (For IBM PS/2)

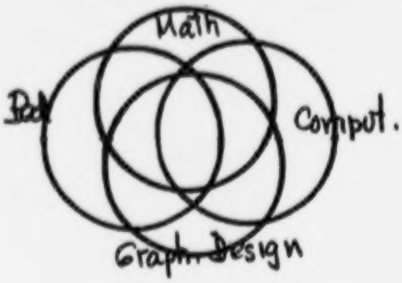
Lesson for secondary level.

COMPANY ORGANIZATION.

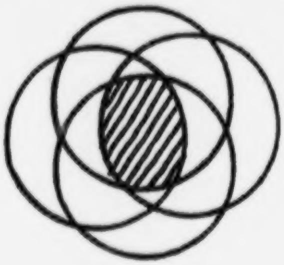
LIBRO ELECTRONICO is integrated by a interdisciplinary staff of specialists in Pedagogy, Mathematics, Computing Systems and Graphic Design. The experience showed us that not is suficient that each specialist cover perfectly their own area.



is essential that each one know most possible other areas in order to have an good understanding and coupling in the work.



In adition is necesary to have a Project Director whose role is to look out for product integrity. This leader need develop skills in all areas and require creativity and good judgment to find faults to make sure the product accomplish with objectives and standards. Many times the project director will provide the central idea of product which will be examinated, modulated and realized by the specialists.



DEVELOPMENT STAGES.

THE PREVIOUS ELECTION:
PEDAGOGICAL BASIS.

The first step in the wide way of educational software development is to adopt an didactic position that will caracterize the product and will orient all stages of develop.

We live in an wide world of diferent cultures, economies, needs; then is very important each country or set of similar countries develop their own educative products accord to reality, requirements, national educational plans etc.

Diferent needs and social objectives originate diferent didactic tendences. Following are presented the main actual tendences that can support diferent educational programs.

MECHANICISM. This tendency promote the mechanical domain of formulas and solution methods, but restrict creativity, investigation and relation with reality. Some drill and practice programs are examples of this type.

STRUCTURALISM. This tendency promote the cognotive development through math structures study. However dont establish relation of math and reality.

INTEGRATIONISM. This new tendency adopted recently in many countries promote whole development. Orient math study in relation with other areas and with objective of trasformation of the world to benefit of the society.

This tendency not disregard value of the others, but see to the math as a tool that helps to explain the fenomenas and relations of the world with purpose of transformation. From this viewpoint the computer no sustitute to teacher neither student - reality relation, but constitute a valuable tool in learning process. Also recognize the big importance of Piaget learning theory with which has many common points.

THE FIRST STAGE:
THEMATIC DEFINITION.

In this phase, a theme is selected and checked its sensibility to be implemented in computer to light of following aspects:

- Implicit dificulty of theme.
- Dificulty to be explained through traditional mediums.
- Computer posibilities to treat it.
  (Graphs, animation, colors, etc.).
  etc.

THE SECOND STAGE:
METHODOLOGIC DEFINITION.

Based on didactic tendency, theme caracteristics and use posibilities is designed a methodology of treatment that can be one or one combination of following:

- Exploration of new concepts.
- Simulation environment.
- Didactic tool to teacher.
- Auto learning.
  etc.

THE THIRD STAGE:
DIDACTIC DESIGN.

This stage is responsability of Pedagogy staff, but is necesary to consider not only didactic tendency and methodologic definition but computer and programming facilities. Independent of type of lesson to be designed its necesary to define:

- Message.
- General description of screen, movements and interaction.
- Nominal and numeric variables.
- Random variables range.
- Text and manipulation on screen.
- Good answer/aproximation/error definition.
  Way of show it. Excluding !good! !bad!.
- Help texts.

- Options and ramifications.
- Suggested sounds and colors.
- Windows.
- Icons.

THE FOURTH STAGE:
DIDACTIC/COMPUTATIONAL INTERFASE REVISION.

Preferently this stage must be make by Project Director. In this phase didactic design is revised to become rich using at maximim the computer posibilities.

In this point is convenient revise:

- attractive screens
- Advantage versus traditional tools.
- Appropiate use cf computer facilities.
- Design clearness to programmers.

THE FIFTH STAGE:
COMPUTATIONAL DESIGN.

In this phase the design become real. Aditional to traditional programming activities appear some caracteristics of educational programs as:

- Answer analysis. This point can require AI techniques.
- Animation techniques.
- Scenaries manipulation.
- Complete manipulation of screens flow. (advance, back, go).
- Sinthetizer programming.
  etc.

THE SIXTH STAGE:
INTERDISCIPLINARY REVISION.

This work must be make in diferent points of programming advance to check general performing of program. In many cases its necesary to correct big parts of product.

Finaly follow some aditionals activities as documentation, field tests, etc. that not intend to be treated in this paper.

December/1988.

LINK: A COMPUTER-BASED MANAGEMENT SYSTEM FOR OPEN-ENTRY, OPEN-EXIT COURSES

J. Bell*, N. Bell^

ABSTRACT

LINK is a set of programs created to manage students as they progress through a wide variety of instructional activities. LINK is well-suited for use with open-entry, open-exit courses in that it has been designed to track student progress through a sequence of tasks which can be grouped in a variety of ways, with the results of this tracking being reported to the instructor and to the student. In using LINK, the instructor periodically collects the student diskettes and processes them with a specially-designed instructor program, collecting information concerning student activities and, in turn, providing the student with summary information concerning the information required to continued with the next phase of the course as well as the progress of the rest of the class. LINK runs in the MS-DOS environment, is menu-driven, and makes extensive use of windowing.

INTRODUCTION

LINK is a set of programs designed designed for use with MS-DOS computers for the purpose of managing students as they progress through a wide variety of instructional activities. LINK is used to track student progress through a sequence of tasks or exercises which can be grouped in a variety of ways. The results of this tracking are reported to the instructor and also summary reports can be made available to the students. In order to facilitate this reporting process, the instructor periodically will collect the student diskettes and process them with a specially-designed instructor program, collecting information concerning student activities, and subsequently providing the students with summary information concerning the success of the rest of the class as well as information required by the students to continue with the next phase of the course.

LINK is menu-oriented and makes extensive use of windowing. Using the menus contained in the various windows, the students can choose to work on new material, or review and practice of previously-taught materials. Students are also able to access a help program and a glossary, both of which are specifically linked to the tasks being undertaken by the students. When LINK is used, each student will have his or her own diskette which is personalized to ensure that it does not become confused with other students' diskettes. LINK records on each student diskette the vital student information which makes the diskette unique to the student to which it has been assigned.

CABILITIES OF LINK

First in the listing of the capabilities of LINK is that it has been designed to manage a curriculum-defined or instructor-defined sequence of instructional activities, tracking student progress, and reporting such progress to the instructor and to the student. Thus, LINK can be used with existing courses in which the instructor has already prescribed a defined set of activities which are to be completed by the students. Likewise, LINK can be used with an existing textbook, and the exercises defined by LINK can be directly related to specific pages in the text.

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Second, LINK has the capability of being programmed to provide stimuli to which students respond and then LINK can assess and record summary data related to student responses. For example, in a math drill, LINK can randomly generate the problems, evaluate, record and reports results, and present additional problems based on the success of the individual students. LINK can also produce referral information for the students to use to gain assistance from other instructional materials or individuals.

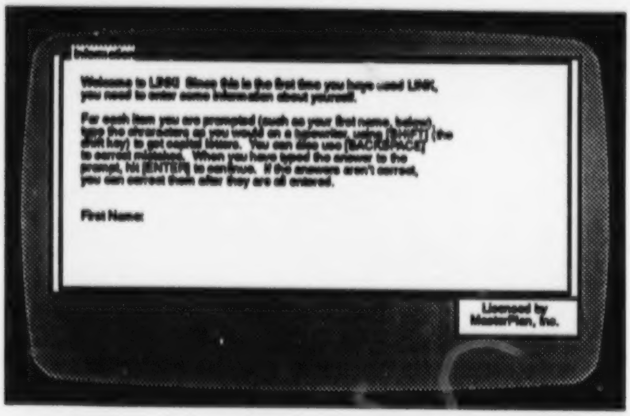
A third capability of LINK is that it has been designed to randomly select and present multiple-choice quiz questions and assess responses to these questions, recording total scores as well as responses to individual questions. In addition, LINK generates additional quizzes based on a formula of one-third new questions, one-third missed questions, and one-third review questions.

Fourth, LINK has the capability of providing a communications system between the instructor and the students. Messages can be prepared by the instructor and sent, via the students' diskettes to all students, or only to selected students. Likewise, the students can use the diskettes to send messages to the instructor.

Finally, LINK has been designed to contain a variety of "built-in" functions, including a glossary, a summary reporting of student achievement, keyboard drills, and instructionally-related games, all of which can be displayed by pressing single keys.

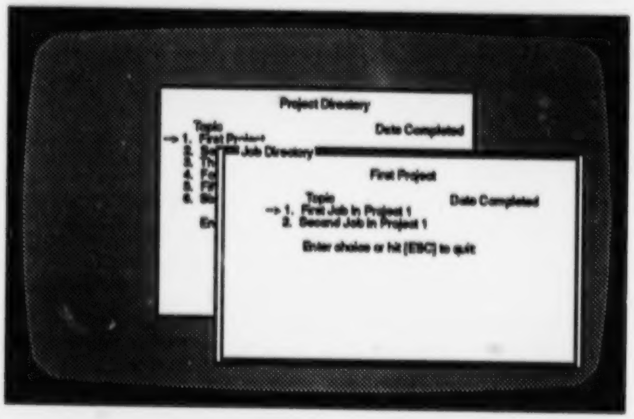
OPERATION OF LINK

LINK resides on either 5.25" or 3.5" diskettes. With the LINK diskette in the active drive, LINK is executed by keying in LNK and pressing the ENTER key. The first time LINK is executed, the user will be asked for certain items of information (i.e., name, address, phone number, etc.) and then LINK will personalize the diskette for that student. After the student has entered the requested information, LINK records it and then automatically executes itself and presents the first portion of the course, consisting of an information screen which welcomes the student to the course. This information screen can be changed regularly throughout the course, presenting up-to-date information concerning the operation of the course or any other school-related information.



First Name:

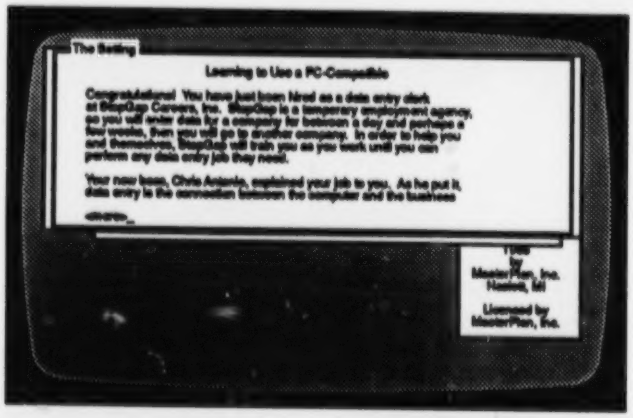
Following the initial information screen, LINK provides an overview of the entire curse. The course can be sectioned in a variety of ways, depending upon the topics to be presented. For example, in a data entry course managed by LINK, there could be a number of projects, each consisting of a series of jobs. The students are led through these projects and jobs sequentially, although it is possible for the students to return to previous sections for review or additional practice, or retries at previously-taken tests. The students make their selections by entering their choice, with what LINK thinks to be the most appropriate selection indicated by the display of an arrow to the left of that item.


Project Directory
Topic
Date Completed
→ 1. First Project
Job Directory
First Project
Topic
Date Completed
→ 1. First Job in Project 1
2. Second Job in Project 1

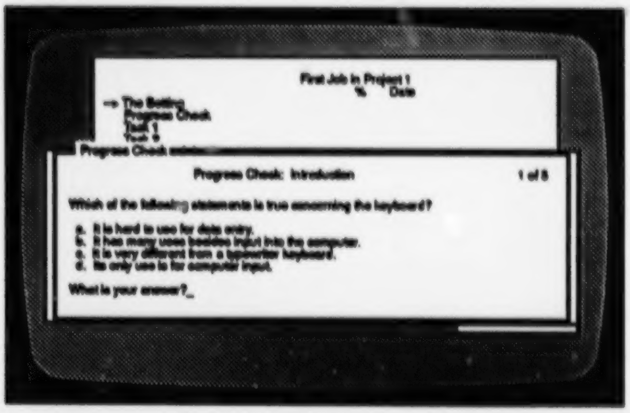
Enter choice or hit [ESC] to quit

When a section is chosen by the student, another menu is displayed, indicating what is to be done for this particular portion of the course. Again, the student is led through these tasks sequentially, although it is possible to return to a previous task whenever it is desired. For example, in the data entry course, the students are allowed to return to any previous section and retake the tests in order to improve their scores.

Each section of the course begins with a brief explanation of the setting of the section. For example, in the data entry course, the students are all "employed" by a temporary service organization, and each day they are sent out to a different location for work. One day they may be filling in at a Motor Vehicles Office of the state and will be required to key in motor vehicle and drivers' license information. Another day they may be filling in at a hospital and keying in patient information. On the screen which explains the setting, the students are provided with the information concerning these particular jobs and their associated responsibilities.


The Setting
Learning to Use a PC-Compatible
Licensed by
MasterPlan, Inc.

The explanation of the setting is following by a multiple choice quiz, administered completely by LINK. This quiz must be passed with a satisfactory performance before the student is allowed to continue with the project. Questions are randomly presented from a collection of questions written for that particular project. Mastery level is established by LINK or by teacher intervention.



First Job in Project 1
% Date

→ The Setting
Progress Check
Task 1
Task 2
Progress Check [illegible]

Progress Check: Introduction 1 of 5

Which of the following statements is true concerning the keyboard?

a. It is hard to use for data entry.
b. It has many uses besides input into the computer.
c. It is very different from a typewriter keyboard.
d. Its only use is for computer input.

What is your answer?_

With the successful completion of the quiz, the students are directed to perform sets of tasks which must be completed in the specified order. For example, in the data entry course, the students will key in information which simulates the kinds of data to be entered in the particular setting the system is simulating. LINK will check and record the accuracy of such student activity, and periodically report the information to the instructor via the submission of the diskettes by the students. In other course applications, the students may be directed to complete specified activities and the instructor will then check the products and assign a code which will be entered by the student to indicate successful completion of the project. This code is personalized to the student and contains information concerning the degree of success on the particular project. Use of other students' codes will be rejected by LINK. Once all the tasks are completed, LINK presents a summary quiz over the entire lesson, and then concludes the lesson with a summary of the section and a short preview of the next section.

SUMMARY

The computer is well-suited to provide management information to learners regarding the most appropriate activity to undertake in their attempt to master a specific body of knowledge. LINK is a set of computer programs designed to support student learning by providing this management information in a timely fashion. LINK, in effect, establishes a two-way communication system between the instructor and the student. From the instructor there is passed to the student information related to what is to be done as well as information regarding the level of success on completed activities. From the student there is sent information concerning responses to quizzes, drills, and other course-related data. LINK has the capabilities of providing the instructor with assistance in instructional management for almost all courses, but has been specially designed for open-entry, open-exit courses in which students can proceed at their own best rate through the subject matter.

COMPUTER LITERACY: THE EVOLVING SCENE

D.A.Sachs

ABSTRACT

The words "computer literacy" have taken on a different meaning during the past five years, as the technology around us has made enormous advances. Teachers are suddenly faced with a sea of hardware and software options that boggle the mind. Even more amazing is the fact that many of these options are owned by their students!

Pace University's School of Computer Science and Information Systems has explored these issues in conjunction with selected advisory boards who were chosen for their ability to successfully represent the needs of our teacher constituency. This author has been actively involved in teaching several of the resulting "computer literacy" courses. This paper focuses on the issues surrounding the concept of "computer literacy" and also discusses some of the solutions which are being provided within the University.

As one of the authors of Discovering Microsoft Works, a software textbook which is being used nationally in "computer literacy" courses, this author is also able to share his perceptions from the vantage point of one who is providing books and software for this rapidly changing marketplace.

INTRODUCTION

As recently as 1983, Gary Bitter stated that "Computer Literacy, as I see it, is made up of two broad areas: Computer Awareness and Computer Programming." (ref 1) In May of 1985, the Illinois-Wisconsin Computer Coordinators declared that "Our definition of computer literacy includes keyboarding, word processing, graphics, data base management, problem solving, algorithmic thinking, and computer programming." (ref 2) In June, 1988, in an article entitled "A Successful Approach to the Computer Literacy Course," Barbara Price and others describe a newly revamped course being taught at Winthrop College which now includes "guided instruction in the use of microcomputers, applications of word processing, spreadsheet analysis, and data management, and elementary structured programming in BASIC." (ref 3)

Pace University's School of Computer Science and Information Systems has experienced a similar tug of war in the process of trying to define a coherent approach towards the concept of "computer literacy". This has been particularly evident in the courses being offered to Pace students who are seeking a Masters in Curriculum and Instruction, a joint program offered by the School of Computer Science and Information Systems and the School of Education.

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In 1983, to learn computing at Pace was to learn (for the most part) how to program a computer. While this was highly successful for those intending to become computer science majors, computer programming raised particular concerns for students who were more interested in elementary or secondary education. First, they were not at all sure why they were learning to program a computer. Second, for those who did find that they enjoyed the experience, there were still those lingering questions about the utility of the newly acquired knowledge. It was with these concerns in mind that the School of Computer Science and Information Systems, in conjunction with Pace's School of Education, began to move toward a more comprehensive version of "computer literacy." This version closely resembles the one propounded in a recent article entitled "Taking 'Computer Literacy' Literally." This definition has four components:

1. Basic familiarity with computers and data processing.
2. The ability to use applications programs.
3. The ability to program.
4. Knowledge of "the ways in which computerized systems are integrated into the social order". (ref 4)

Teachers who are enrolled in the Masters in Curriculum and Instruction degree at Pace take primarily education courses, but have a concentration in computers. The three courses which have been specifically developed with these "computer literacy" concepts in mind during the past four years are CS501, *Introduction to Computers and Computing Systems*, CS505, *Use and Evaluation of Program Packages*, and CS506, *Instructional Applications of Microcomputer Technology*.

CS501, *Introduction to Computers and Computing Systems*, is the beginning course in the sequence. The course provides "An introduction to the fundamental topics of computers and computing systems. Intended for students with no computing background, topics include problem solving and algorithmic design, an introduction to computer systems architecture, an introduction to operating systems, and an overview of database systems and concepts."

The course textbooks, Introducing Computers by Blissmer and Discovering Microsoft Works by Sachs and Kronstadt, are intended to provide students with both a general introduction to computers and computing, as well as with a specific introduction to a powerful set of computer applications, namely, a word processor, a database, and a spreadsheet. It is assumed that students will be somewhat comfortable with computers in general after this course, and that they will at least have taken a "first pass" at productive computer usage.

CS505, *Use and Evaluation of Program Packages*, is a more difficult course, in which the two objectives are "(1) to provide complete facility with several program packages, and (2) to develop an ability to evaluate one program package relative to others with respect to a variety of criteria." Here, students become more familiar with a wider array of software. While the focus is still primarily on word processing, database management, spreadsheet programs, and graphics packages, students are expected to be (and are) much more knowledgeable by the end of the semester. The emphasis is on the mastery of these program packages, and on the integration of them into the students' professional lives.

Students learn about two or three word processors (Microsoft Works, Professional Write, Word Perfect), two or three database management programs (Microsoft Works, Professional File, DBase III+), two spreadsheet programs (Microsoft Works and Lotus 1-2-3), and several graphics packages (Harvard Graphics and IBM Storyboard Plus). The emphasis is on the mastery of at least one of them, and a thorough understanding of the others. Using How To Buy Software by Glossbrenner, and several sets of materials prepared by the Pace Computer Learning Center, students are able to "make the software their own." Each student must complete a significant project in which they utilize several of the software programs.

CS506, *Instructional Applications of Microcomputer Technology,* has several objectives. The course is intended to teach teachers how to use new technology to:

1. assume time consuming management tasks;
2. prepare tools of instruction;
3. enable students to direct their own inquiry;
4. provide programed learning experiences;
5. provide open-ended learning environments.

For texts, students use The Micro Goes To School by Troutman and White and The Information Age Classroom by Cannings and Brown. The primary focus of this course is to familiarize students with the wide array of software which is available for Computer Directed Instruction, Computer Enhanced Instruction, and Computer Managed Instruction. In addition, students become more aware of the wide world of people and issues in educational computing by reading and discussing many of the articles in The Information Age Classroom.

It has become clear that students who complete all three of these courses have become "computer literate." That is, they have learned how to integrate the computer into their professional lives in an indispensable fashion. This is corroborated by one student who said recently at the end of CS505, "I know this sounds crazy, but I can hardly wait for school to start again, so that I can begin to really use all that I have learned." When a tool such as a computer and the requisite software have become an integral part of one's professional life, then one is certainly well on the way towards "computer literacy."

The issues that have been of concern to those of us who have been actively involved in designing these courses for the School of Education during the past four years, have also been a part of the process which this author encountered while writing Discovering Microsoft Works and Projects In Microsoft Works during this past year. We spent a great deal of time trying to devise activities and exercises which were both challenging, meaningful, and potentially useful to our anticipated audience. While the texts are written primarily with the college age student in mind, the exercises proved to be equally challenging when used with graduate students. While it is certainly true that one of the goals of these books is to provide the students with a thorough introduction to all of the power of Microsoft Works, another, probably more important goal, is to promote computer literacy. Students who complete the many exercises in the two volumes have learned so many ways to use the software, that many have stated that the computer and the software have become an integral part of their personal and professional lives.

This integration is typified by the student who recently compiled a massive database of his video tape collection, another student who prepared a whole set of letters, a complete database, and a preliminary budget for the private nursery school which she runs, and a fifth grade teacher who devised a whole series of personalized reading exercises for his students, using information which he had obtained from them and then inserted into his class database. What is impressive about all of these projects, is that they were completed by students who had never done such activities before the course (CS505) began.

It is likely, as the world of computer technology expands, that the definition of computer literacy will change as well. On a recent night in class, students were involved in a lengthy discussion of HyperCard, CD-ROM, scanning devices, and telecommunications, all of which are new and potentially powerful technologies for educators. Certainly, as the cost of these technologies declines, and as their availability increases, they too should be included in the University's definition of "computer literacy." In the meantime, Pace's School of Computer Science and Information Systems seems to be doing a good job of providing teachers with a powerful introduction to word processing, database management, spreadsheets, graphics packages, and Computer Directed, Enhanced, and Managed Instruction. Our students are well on their way towards becoming "computer literate."

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4. C. Van Dyke, *Communications of the ACM*, Vol 30 No 5, (1987)

STUDENTS' USE OF ANALOGIES OF COMPUTING CONCEPTS IN COMPUTER LITERACY EDUCATION

Galloway, J. P.

ABSTRACT

The use of analogies to understand computing concepts is useful for improving learning in computer literacy. Analogies serve critical roles in the internal representation of ideas. Students' understanding of analogies and their use of analogies to explain computing concepts can be useful indicators of what students are learning.

Although it has been shown that students suffer from misunderstandings and limited mental models of computing, there are many things yet to be learned about how to improve the education of inservice and preservice teachers. Data on students' use of and understanding of analogies of fundamental computing concepts is presented and discussed. It is suggested that learning might be improved through the use of analogies in teaching.

INTRODUCTION

As state requirements across the country for K-12 grow to include computer courses, the need for computer literate teachers grows as well (ref 1). There is a serious lack of empirical research on what students learn in college level computer literacy courses and how such computing courses should best be taught. Educators are still not in agreement about what teachers need nor how to teach them (ref 2). Students' use of and understanding of analogies can be a valuable indicator of what they are learning. Student teachers' misconceptions and limited understandings can have a significant effect, not only on their own use of computers in teaching, but for their students as well.

ANALOGIES AS A CRITICAL THINKING SKILL

Analogies can play an important part in the development of new things and new ideas. Sampson (ref 3) speaks of "seeing" in the mind the relationships between ideas causing a new whole, a new understanding. In trying to understand new ideas, students can benefit from an analysis of a concept's attribute's, necessary and coincidental, and in seeing how that concept relates to other similar ideas or situations. This examination of relationships, making comparisons and searching through information, is described as "the core of analytical reasoning," (ref 4, p. 19).

The process of analysis of analogies is fundamental to comprehending any kind of knowledge (ref 5). Understanding computing concepts, e.g., memory, input-output, etc., with the help of analogies can provide a deeper comprehension of the

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concept and improve the internal representation of ideas which is crucial in problem solving (ref 6). "If analogies speed the formation of differentiated schemata, then comprehension and solution of [problems] should be facilitated," (ref 7, p. 80).

Also, analogies can help students explain ideas (ref 5) and can be quite revealing of what model(s) of understanding, accurate or inaccurate, a student possesses. While one may see a given concept as highly analogous to another, analogies, in serving the learning process, are highly individualistic. Halpern (ref 7) illustrates this point by referring to the use of a solar system concept to understand the structure of an atom. If one knows nothing about a solar system then the analogy is useless. But, if an analogous concept is well understood by a student then the analogy can be particularly useful in developing an understanding of the target concept (ref 8).

ASSESSING LEARNING IN COMPUTER LITERACY

Empirical research examining what is learned in computer literacy is only beginning to be conducted. Research into the development of specific computing concepts in computer literacy (ref 9) is most rare. Gabriel (ref 10) has used paper and pencil methods to test for achievement of general computer literacy objectives such as awareness of computer use and problem solving, but without reference to analogies or fundamental computing concepts.

Children's notions of computing concepts and their use of language to explain computing has been examined through interviews (ref 11). The analogy of human thinking for computer functions was also explored during those interviews. It was shown that, in spite of clearly understanding the relationships between human thinking and computer operation, students had weak mental models, misconceptions and confusion about computing.

METHODOLOGY

A Spring 1987 study was conducted to explore computer literacy students' level of understanding of and their ability to relate to analogies of computing concepts. Both pre/post written tests (n=27) and personal interviews (n=6) were administered to volunteers of a required undergraduate computer literacy course. Five concepts were studies: command, data, file, language, and program. Two interviews sessions were held; once about midway through the course (after Logo and word processing) and once at the end of the course (following database, spreadsheet, and BASIC). Students' use of analogies during the interviews were noted in writing and were recorded on audio tape.

The written test (40 items) had eight items for each of the concepts which were also classified by question type: examples (10 items), attributes (14 items), and analogies of the concepts (16 items). Each question was multiple choice with four foils. Some of the analogies on the written test included (a) a wallet or purse for File, (b) a light switch for Command, (c) fire drill procedures for Program, (d) a set of traffic laws for Language, (e) recorded music for Data, and more.

A variety of analogies are possible of course and could be used to explain any of the concepts. The interviews were conducted privately and questions were open-ended allowing for discussion and explanation. The subjects were asked to explain the five concepts and their definitions and use of analogies in the interviews was particularly noted. Some of the analogies for the five concepts which one could offer in explanation include the following:

Data:	Recipe ingredients; numbers on a combination lock.
Command:	Stop sign; push or pull signs; an ignition switch.
File:	A refrigerator; a book shelf; a glove compartment.
Language:	English; Spanish; a template.
Program:	A recipe; a treasure map; a wash/rinse cycle.

Each of the two interviews occurred following both the use of commercially prepared utility software and programming activities. Subjects were therefore exposed to all five concepts in both contexts.

RESULTS AND DISCUSSION

Interview subjects offered no analogies in explanation of any of the concepts. During the interviews there were opportunities to explain a variety of computing operations and software. Only one analogy was offered by the subjects to explain anything in either interview, namely that a word processor is "like a typewriter, only easier." Subjects' ability to explain and discuss computing was extremely limited and confused. They generally did not use technical terminology and quite often answered "I don't know" to many questions. The one analogy used by interview subjects was used by the instructor during the course.

On the written test, subjects did most poorly on analogy and attribute questions. The examples subscale had a higher posttest mean (74%) than either the attributes subscale (51%) or the analogies subscale (54%). The posttest scores did indicate overall improvement during the course (pretest mean = 13.4, posttest mean = 23.6). The poorest performance on analogy questions occurred on concepts of language, data and file with the best performance on the concept of command. For example, the majority of subjects believed that a reference manual for home repair was a better analogy for program than for computer language. This could be due to students' belief that a any part of a computer program is accessable at any time (as compared to the usual sequential execution). Also, subjects viewed numbers on a combination lock as more analogous to commands and programs than to data. This could be due to confusion between an instruction (turn left, stop, turn right, etc.) and the data which an instruction may manipulate. A book shelf was viewed as more like data than a file possibly indicating confusion between information and the place where information is stored.

It seems clear that computer literacy students have serious misconceptions and confusions about fundamental computing concepts. The need for teachers to impart accurate and complete knowledge to their students warrants a more technical and more complete understanding. The interviews provided significant evidence of the subjects' lack of such an understanding as they were universally unable to satisfactorily explain any of the concepts. The interview results were generally consistent with written test results.

The almost complete lack of analogies by the interview subjects seems to indicate that, not only do students have a poor conceptual base and a serious difficulty with explanations, but also that the use of analogies in the classroom by both the instructor and the student is insufficient. It seems advisable for educators to use more analogies to help students develop a clearer, more complete and longer lasting understanding of computing.

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THE COMPUTER IN THE FOREIGN LANGUAGE CLASS : ATTITUDES, ROLE, POTENTIAL AND USES.

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ABSTRACT

The attitudes towards computers vary from positions which view them as "dangerous enemies", "de-humanizing machines" to perfect devices and so with an inquestionable value.
Which of these views shall modern language teachers adopt ?
It is the author's belief that computers cannot either be rejected or used at the service of traditional strategies, thus using our time technology with past-time processes.
Teachers of this area, in the author's point of view should use the computer in two main ways: either as a tool, making use of programs like the word processor or as exploring its immense potential as "electonic materials" builder.
What a foreign language teacher should have in mind when using a computer is that he has to stimulate the interaction among students, thus viewing the computer as one of the participants in a communication process, not the only one, not even the most important.

INTRODUCTION

This paper is a result of some experiments made with secondary school students, together with the reflections I have been doing on the use of the computer in the foreign language class.
It is not my intention to cover all the issues related to the subject, but to give my personal view about what I have learnt - through the experiments, their evaluation, the contact with some teachers and my own reflections.
That is the reason why my concern is to explain how the activities I devised work, when used within a classroom. Thus, other possible ways of using the computer in the teaching and learning of a foreign language as well as the parallel activities that can be done together with the work with the computer are not part of this paper.

THE ATTITUDES TOWARDS COMPUTERS

The importance that the computer is acquiring in the several aspects of everyday life has been accompanied by some typical attitudes.

Some view it as a cold, dictatorial, de-humanizing machine ; others as a potential dangerous enemy able to prescrute our deepest secrets; others face the computer with cepticism, fear and mistrust and there are those who consider that everything the computer does is perfect and thus its value is out of the question (ref 1).

Moving this attitudes to school it is common to find teachers who either definetely reject the use of the computer in any activity, as a perfectly dispensable devise and, even, causing trouble to their way of teaching,

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or those who, finding in the computer potentialities never dreamed before, place it at the service of traditional strategies.

I think that neither of these attitudes is right.
Actually, if the computer cannot, and should not, be simply ignored and kept out of school, on the other hand it cannot be seen as being able to solve all the problems that teachers and students face on the teaching and learning process.
The use of the computer at school, I believe "may be conducted in either a good or a bad manner and that depends not on it but on ourselves" (ref 2),e.g. a creative teacher concerned with the diversification of strategies, moving towards the interests and motivation of his students, will have no difficulty in integrating the computer in his practices, viewing it, thus, as a valuable technological auxiliary which enables the conception of more motivating, thus richer, activities,in which the student takes an active role. If the computer is faced this way it becomes a tool and one more resource at the teacher's disposal.
On the other hand, a teacher who uses more traditional practices, views with concern the introduction of such a machine in his classroom or, when finally convinced to use it puts it at the service of his routine activities, as if it were a "robot teacher" or an "audio visual book", thus imitating traditional roles.
If used in the latter way the computer is in risk of following the same route of other teaching auxiliary means, once considered "revolucionary", as the overhead projector or the language laboratory which are often used as a resource of the teacher to conduct expositive classes, or in habit formation activities that have little to do with the methodologies that are suggested nowadays to the field of teaching we are concerned about.

The computer, I believe, rather than a teaching auxiliary means should be regarded as a powerful learning device, with which the student instead of "being programmed", "programmes", not in the technical sense of the word but in the sense that he should participate in an active way in the proposed activity.

THE ROLE AND THE USES OF THE COMPUTER IN A FL CLASS

Now, assuming that we recognize the usefulness of the computer in a foreign language class, what options should be taken ? Should teachers use "ready-made" software ? Should the computer be used as a tool, thus using the "utilitarian software" kind, such as data bases, word processors, etc.? What other ways are there to use the computer within the classroom ?

As for "ready-made" software, e.g. those programmes intended to be immediately used in specific areas, where everything is pre-programmed and pre-seen, the problem can be faced in different ways.
In Portugal it is very difficult to find software to be used in a foreign language class that matches the current trends in the teaching and learning process. We have no programmers, no "industry", no distribution. We know of some foreign institutions (British Council, for example) that develop and possess many programmes suitable to be used. But then problems of compatibility make it impossible for them to be used in the outside.
What is, then, normally available, as a result of some individual effort, are multiple-choice activities kind, with many blinkings, some special effects, this or that melody, a reward for the winner, in which all the

students does is to press a key and wait for the answer. Without questioning the value that such programmes may have in special circumstances (individual remedial work, for example), they are not suitable to be used in a normal classroom situation, in which, as we know, there should be a great stimulus to communicative activities, to the search of interaction among students.

On the other hand, we can always adapt some of this software to match our needs. That is the case of what I have done with LITTER,(ref 3).

It is a simulation in which a candidate to local counsellor has got ten weeks for a re-election campaign, during which he has to take some options as for the best way to collect the litter in his town ; each option has got its costs, either in terms of money , or in terms of popularity. It seems a well devised programme and with some potential. But if we use it as it is, the result is not famous: the student presses a key and waits for the answer. But if we divide the class in groups, each group with a "candidate" being the other members of the group his "staff"; if the "candidate's staff" has the mission of studying the alternatives, their costs and effects; if, then, they transmit their conclusions to their "candidate" and if this follows the instructions , there we have a better way of using a "ready-made" programme.

Another potential use of the computer in a FL classroom is by means of what I called "utilitarian programmes", e.g. those programmes intended to be used as support to everyday tasks, like the word processors.

So, if the word processor is to be used as a tool for the development of activities that integrate more than one skill in foreign language learning, and not only writing or reading, then immmense potentialities are discovered.

I have been using the word processor WORD (ref 4) for interaction stimulus activities, in which students are elicited to listen, read, speak and write.

One possible example is to use the "strip story" technique, e.g. a short text divided into small paragraphs, which are to be known by students in a random order; the objective is to read the paragraphs, understand them and then order them in the correct and logical sequence. Using the computer, the paragraphs are saved in a glossary variable; a student is asked to type the name of the variable we give; the paragraph is read and discussed and printed on paper; then it is deleted and the process is repeated untill all the paragraphs have been discussed. The class must then discuss (interact) in order to find the correct order of all the paragraphs and when this has been done, all the paragraphs are then loaded, this time in the correct order. Finally the complete story is printed on paper.

Other possible way of using the computer in a FL classroom is to explore its immense potential as an "electronic materials builder" for the teaching and learning process. If used for that purpose the teacher will dispose of the possibility of devising auxiliary activities that the static material does not have , thus being much more motivating and efficient.

That is what I have been doing with LOGOWRITER (ref 5), whose final products do not demand more than basic Knowledge of that LOGO version.

One of the activities I have used is what I called "MAP", in which a town map is drawn , with a human figure that can be moved throughout the whole screen, according to instructions either given by the teacher or by a fellow student. The aims of the "trip" can vary: either just to reach a certain point in the map, or to write the names of a certain street or building, or to make some houses appear, or to "plant" some trees, etc. This very simple activity join the relative easiness of construction to the animation that is created, which is impossible to get with a pencil and a sheet of paper.

CONCLUSION

Throughout this paper I have stressed the importadnce that should be given to the use of the computer as a facilitator of the communication among students, which, I believe, is to correct way of using this extraordinary machine in a FL classroom.

In fact, the computer cannot be an intruder within the classroom, or just a tolerated machine, nor it can become the target of all attentions, making the students forget about his fellows, establishing a relation only between him and the machine.

What is essencial is to make the computer one of the participants in a communicative process, which, althoug passing through the machine, spreads to everybody, searching the interaction among all.

Thus used the computer will never be an obstacle to communication, but rather a facilitator of the interaction.

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TEACHER ATTITUDES TO THE USE OF COMPUTERS IN SCHOOL

Jean D. M. Underwood[1] and Geoffrey Underwood[2]

ABSTRACT

Our aim was to assess teacher attitudes to the educational use of computers. A survey of teachers and trainee teachers attitudes (sample size=313) was conducted over a three year period. The sample as a whole expressed positive attitudes four times more frequently than negative attitudes. Four clusters of teachers were identified expressing views along a continuum from highly positive to weakly negative. Variations in attitudes were positively related to computer knowledge and awareness, which in turn was related to the age of child taught and whether the individual was still in undergraduate training. These results suggest that positive attitudes to the computer can be generated by appropriate first-hand experience.

INTRODUCTION

A number of recent studies suggest that people are well aware of the increasing impact that the computer will make on their lives. For many groups there is excitement and acceptance of the benefits that the computer will bring, but others are more cautious. Teachers, in particular, express reservations about the computer, only 64% of teachers thought that computers would improve education, compared to 96% of educational administrators, and only 36% felt that a computer in their classroom would help them to be a better teacher (ref 1). Teachers were fearful of the machine taking over their jobs; were unsure of their role in a computer rich environment and felt that they had neither the time nor the incentive to come to grips with the technology and the new pedagogical techniques it required (ref 2).

The hypotheses underlying the present study were that attitudes to the use of computers would be related to four variables. These were (i) teachers' knowledge of the computer, (ii) area of expertise, (iii) age-range of pupils taught, and (iv) as the study was conducted over a three year period, a difference in attitudes over time. Previous research suggests a difference in attitude to the computer across the sexes (ref 3), but the preponderance of females in our groups left no scope for an investigation of gender differences.

METHOD

The Sample: 313 teachers and teachers in training were sampled, all of whom were at the start of a short, compulsory computer literacy course. The survey was conducted over a three year period from the academic year 1983/4 until 1985/6. The subjects worked across the educational age-range and were categorised into three groups: workers with pupils in their Early Years (3-8 years); Middle Years (8-12 years); and Later Years (11+ years). The subjects were further categorised as students on the B.Ed programme (59% of the sample), students on the Post Graduate Certificate in Education (PGCE -18%), or, teachers (minimum three years' experience - 23%).Approximately one third of the sample taught Early Years (32%); 48% the Middle Years; and, 19% were secondary and further education teachers (Later Years).

The Questionnaire: Section One of the questionnaire collected biographical details on age-range taught, area of expertise, experience with and awareness of microcomputers. Section Two comprised 29 questions designed to assess attitudes to the use of computers in education. The questions formed three groupings: the extent to which teachers felt that knowledge of the computer was relevant to pupils and to themselves; the impact of computers on the teaching/learning environment; and the contribution of the computer to all or part of the curriculum. Subjects' attitudes were measured by the degree of agreement registered upon a five point Likert-type rating scale. Questions were structured so that positive responses to the computer were randomly organised to elicit approximately equal numbers of scores at each end of the rating scale.

Procedure: Subjects were tested at the onset of the computer awareness module before any formal work with the microcomputer had begun. Subjects were informed that the purpose of the questionnaire was to gather information concerning teachers' perceptions of the usefulness of computers in the classroom.

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RESULTS

Scoring: The initial biographical material was classified on the dimensions of age-range taught (Early, Middle and Later Years); type of student (B.Ed., PGCE or practising teacher); and computer awareness. The 29 attitudinal questions all recorded a score of between 1 and 5 points on the rating scale.

Analyses: An item analysis confirmed the internal consistency, reliability and validity of the test items. The questionnaire achieved a Cronbach alpha score of 0.85, indicating acceptable reliability; and a domain validity coefficient of 0.92 (ref 4). Thus all twenty-nine items went forward for further analysis.

The Cluster Analysis: Correlational techniques confirmed that the items were not independent. There was a small group of items, indicating negative attitudes, which were strongly inter-correlated and a much looser network of items, indicating positive attitudes. Cluster analysis was applied to the 29 attitudinal variables. Analyses were completed for standardised data. A second analysis, using a half sample was used to test the validity of the cluster solution.

The Diagnosis of Clusters: A dendrogram showed that two-, four- or five- cluster solutions were worth investigation. The five-cluster solution was rejected both in the interests of parsimony and its failure to be identified on the fusion graph. A comparison of the cluster solutions (Table 1) shows that clusters 4.2 and 4.4 in the four-cluster solution are refined versions of the two cluster solution, representing the pro- and anti-computer groups respectively. No members of the original cluster 2.2 (anti) are members of the pro-computer group (cluster 4.2) in the four-cluster analysis. The same stability is present in the new anti-computer group, cluster 4.4. The new clusters 4.1 and 4.3 take members from both of the 2.1 and 2.2 clusters; 4.1 collecting equal numbers of subjects from the original pro- and anti-groupings, while 4.3 is weighted towards subjects from the anti grouping. These two new clusters indicate a greater variation of opinion than is revealed by the two cluster solution. The composition of the groups suggest a continuum of opinion from positive to negative.

Table 1: A Comparison of the Membership occurring in the Two- and Four-cluster Solution groups (all data).

		Four-cluster Solution			
		4.1	4.2	4.3	4.4
Two-cluster	2.1	43	84	30	
Solution	2.2	42		53	53

Analysis of the item groupings confirms that the four cluster solution adds considerably to our knowledge of respondents' attitudes. Cluster 4.2 (84 respondents) and 4.4 (53 respondents) are the extreme ends of a continuum. In cluster 4.2 twenty-five, out of a possible twenty-nine item scores, are significantly above the mean of the clusters, as measured by the Scheffé atypicality test, that is, towards the more positive perception of the computer. No item is significantly below the mean of the clusters, for this cluster. Similarly the negative cluster 4.4, records twenty-seven scores significantly below the mean of the clusters with no scores significantly above the mean. Clusters 4.1 and 4.3 are clearly different from those at the ends of the continuum. Each is composed of a reduced number of items in comparison to clusters 4.2 and 4.4, with items both significantly above or below the mean of the clusters. The comparability of the full and half-sample solutions was indicative of a stable solution and the internal validity of the classification.

A Description of the Four-cluster Solution: Strong belief in the relevance of computer skills was expressed by the sample as a whole, and by each of the four cluster groups. All groups saw the need for future generations to be computer literate. Overall negative responses were recorded on only four questions, each relating to the usefulness of the computer in the Fine and Performing Arts. The groups saw the computer, if not as firmly Maths/Science based, then as of very restricted use in the Arts, and of qualified use in the Humanities.The pattern of attitudes towards the computer can be seen in Table 2. The dominant feature is the strength of the pro-computer attitudes expressed by cluster 4.2. On only one question, the use of computers in physical education, did this group express a clearly negative attitude. By comparison group 4.4 was less certain in its anti-computer views; there were an equal number of negative and neutral items plus four positive perceptions. Although groups 4.1 and 4.3 each drew members from the pro and anti clusters in the two-cluster solution, they are two distinct groups. Cluster 4.1, although positive overall, is composed of people with rather weak views. The members of group 4.3 held firm, largely positive views, but had certain reservations and were less euphoric than group 4.2.

Table 2: Comparison of Responses to the 29 Questionnaire items for the Four Clusters

Cluster		Nature of Item Response		
		Positive	Neutral	Negative
4.1	N=86	10	17	2
4.2	N=84	22	6	1
4.3	N=83	14	9	6
4.4	N=53	4	13	12
Sample Mean		16	9	4

A neutral response is defined as any mean response lying between 2.50 and 3.49.

Interpretation of Clusters: A summary of the biographical details of the clusters is shown in Table 3. One initial hypothesis was that attitudes would become more positive towards the computer over time, but this hypothesis was not substantiated by Chi-square tests. There was no effect of 'Year of sample' across the four cluster groups (X^2=0.45; df=3). Level of computer awareness did influence attitudes, however (X^2=5.89; df=3; $p<0.001$). The members of cluster 4.2 were significantly more knowledgeable about the computer than those of the other cluster groups (Table 3), and were more likely to teach the middle or later years, confirming the influence of age-range taught on attitudes to computers (X^2=3.06; df=3; $p<0.03$).

Table 3: Biographical Details of the Membership of the Four Clusters (Non-standardised means)

	Response Means for Clusters			
Characteristic	4.1	4.2	4.3	4.4
Teacher type: BEd.,PGCE, Teacher.	1.7	1.8	1.65	1.28**
Year of sample.	2.28	2.23	2.34	2.32
Age-range taught: Early, Middle and Later.	1.26	1.64**	1.19	1.11
Level of Computer Awareness.	6.02	6.46*	5.88	5.74

Specific comparisons between groups using Scheffé's atypicality test. * $p< 0.05$ ** $p< 0.01$

The final hypothesis, that teacher-type would influence attitudes, was also substantiated (X^2=4.57; df=3; $p<0.004$). Group 4.4, the least positive group, had significantly more B.Ed. students than other groups. There was no significant difference from the sample mean of teacher-type for clusters 4.1, 4.2 or 4.3. Subjects' areas ofacademic expertise were classified as: Science and Mathematics; the Humanities and Languages; and the Arts. Chi-squared tests revealed a weak relationship between academic area and attitudes (X^2=9.89; df=4; $p<0.05$). Scientists were over-represented in cluster 4.2, the most positive group, while students of the Arts were over represented in cluster 4.4 (negative attitudes). Proportionally, Cluster 4.1 had a balance of all academic areas, but cluster 4.3 had more workers in the Humanities.

Cluster 4.1: 'Neutrals': consisted of 15 items; 5 items were above (+ve) and 10 items below (-ve) the mean of clusters. This group expressed neutrality towards the computer, or at best a guarded positive attitude (Table 2), with positive attitudes to computer use in Maths and Science, negative attitudes in Performing Arts and neutrality to in Art and Religious Education. The group was neutral on such issues as the promotion of child centred education, programming and the question of funding. The group was representative of trainee and trained teachers, at all age-ranges, and had a moderate knowledge of the computer.

Cluster 4.2 'High Expectations': consisted of 25 items above the mean of clusters. This group (Table 2) was excited about classroom computers, which they believed would alter education for the better, resulting in a more child-centred and child-directed education. They did not fear that education would become de-humanised or mechanistic and were keenly aware of the importance of computing skills in general, and the benefits of programming in particular. The non-mechanistic view of the computer was fused with beliefs about the value of the computer across the curriculum. The group taught older children, were more computer literate than the other three cluster groupings but did not significantly differ from the mean on type of teacher.

Cluster 4.3 'Conditionally Positive': consisted of 12 items with 6 items above (+ve) the mean of clusters (Table 2). The group was positive towards the computer and excited about its role in education but that role clearly lay in Mathematics, Science and, to a lesser extent, Modern Languages and not in the Arts. Programming skills were valued but the computer was not seen as programming children. It was seen as an adaptive tool more useful than worksheets and providing new educational opportunities in the use of computer games. The members of this group were representative of the whole sample.

Cluster 4.4 'Anti- Computer': consisted of 27 items all significantly below the mean of clusters but only 12 out of 29 statements were negative. There was a large measure of indecision in this group. While computing skills were seen as vital for the next generation and programming as useful, the group was unwilling to be involved with the computer. It was seen as a tool for Mathematics and Science not Arts and Humanities, with indecision over its value in Language teaching. This division of subjects related, in part, to a perception of fact orientated teaching in Science and the view that the computer is best suited to basic or low-level skills practice. This group felt that the computer would de-humanise learning. The group was disproportionately composed of BEd trainees but with equal representation across the age-range and experience level.

DISCUSSION

Grouping by Attitude: The sample as a whole expressed positive attitudes four times more frequently than negative attitudes. Positive attitudes concern the potential of the computer to promote more child-centred learning and its usefulness across the curriculum, uses which have been discussed by the authors (ref 5; ref 6). Negative attitudes were related to low computer awareness. In only one area, the role of the computer in the Arts, was there a negative consensus. Even the most antagonistic group, cluster 4.4, accepted the computer's relevance to society. Two of the groups were positive in their views (55% of sample); one group was dominated by indecision (27.7% of sample); and, one group was negative (17.3%), although even here indecision was more prevalent than negative statements. The *High Expectations* cluster (4.2) were more definite in their views than the *Anti-Computer* group, or machine-phobics, who were undecided, or held weakly defined views, on nearly 50% of the questions.These findings suggest a wealth of good will, or at least neutrality, towards the use of computers in schools. The differences between the two pro-computer groups lie in the *High Expectations* group's (cluster 4.2) cross curricula view of the computer compared to the more limited scientific role of the computer outlined by the *Conditionally Positive* group (cluster 4.3).

The *High Expectations* group's positive attitudes are based on reasoned judgement. The group was not only more knowledgeable about the computer than the other three groups, the members showed an awareness of the many ways in which the computer can be used. For example, subject 261, declared that 'The computer can perform as a highly efficient calculator', but added the rider 'but this would be a total waste of the resource'. An acceptance of the more complex functions of the computer goes hand-in-hand with greater knowledge of the computer. The *Anti-Computer* group was low on computer knowledge and had a higher proportion of BEd. students and those in the Arts than any other group. There is a paradox in this group's acceptance of the relevance of the computer, while they express no personal interest or value in the machine. It appears to be a case of 'I know it's good for me but don't expect me to get involved!'

Our initial concern of a predominantly disinterested and possibly hostile teaching profession proved ill-founded. Nearly half of our sample expressed very positive views towards the educational computing, while a further 25% had no strong prejudices. Most encouragingly those who rejected the computer based their opinions on limited knowledge. These results suggest that many of the *Anti-Computer* group could develop more positive attitudes given first-hand experience of the machine. One caveat would be that experience should be relatively trouble free and relevant to the direct needs of the group.

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Technophobic to Techie: Technology Staff-Development Which Overcomes Teachers' Technological Inhibitions and Inertia.

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ABSTRACT

The implementation of technology is an ongoing enterprise. Yet, many methods of training have failed to motivate and empower the primary agents of change in the schools with this technology - teachers. This paper presents a case report of the process and the subsequent empirical outcomes of a staff development model created and implemented in the Cupertino/Fremont site of the State of California's Model Technology Pilot Program Model Technology Project (CF-MTS). This model of training incorporated the major components of Bandura's (1986) interpretation of social cognitive learning theory: structured mastery experiences and guided practice of newly modeled activities in a natural setting with mastery and peer models. This case report discusses the outcomes of the staff development model on the teachers involved in this powerful process.

INTRODUCTION

The trend towards the use of multimedia (i.e., videotape, CD-ROM, interactive software, and video camcorders) and the infusion of computers into the schools has been occurring over the last 10 years at an increasingly higher rate. It has been observed that established teachers are ill at ease using these technological tools. This problem is equally true for preservice teachers. They, too, are unfamiliar with these new technological tools, since they spend over 15,000 hours of their lives as students, in what is referred to by Lortie as the "apprenticeship of observation". It is these cumulative hours spent in the classroom, argued Feiman-Nemser (1983), that gives preservice teachers powerful preconceptions of good teaching. These preconceptions remain with them as they become experienced teachers. The arguments put forth by Feiman-Nemser challenges teacher education and other staff development programs to reeducate teachers to use these new and exciting tools and to establish in both experienced and preservice teachers the ability to teach for conceptual change.

BACKGROUND

Most experienced teachers entered the technology revolution without adequate training or knowledge of technology and were faced with their own preconceptions of life in the classroom. At the beginning of the revolution, their biggest fear was that the technology would replace them. Currently, their conception is that technology is not a foe but a tool to enhance the student's experience in school and to better prepare the student for the future. However, in order to effect further change, the experienced teacher's preconceptions and methods of teaching in tomorrow's classroom must be confronted by a powerful intervention. This intervention must be provided by programs to implement technology into the classroom. Because, until teachers learn to

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fully incorporate technology into their classroom, any implementation plan for educational change will fail.

METHOD AND RESULTS

How can teacher preconceptions towards technology be changed? The following model of staff-development, used in the Summer Institute of the Cupertino/Fremont Site of the State of California's Model Technology Pilot Program ([CF-MTS], see Appendix A), incorporated the major components of Bandura's (1986) interpretation of social cognitive learning theory. Bandura believed that to bring about cognitive changes through modeling one must use modeled activities that generate personal involvement through participant interest, attention, and active involvement. The staff-development method in the CF-MTS Institute used these principles by structuring Mastery Experiences and guided practice experiences of newly modeled activities in a natural setting using both mastery and peer models.

The institute was held over the period of five days and provided for the participants structured mastery experiences and guided practice experiences of newly modeled activities. To invoke greater awareness of their own performance and, if necessary, to perfect their ability to manipulate a variety of technological equipment and computer software, the teachers were provided with immediate feedback and follow-up activities. The steps of the staff-development model included (see Figure one):

1. **Observational learning process** (Vicarious Learning , Mastery Modeling) - applications of various technologies in a number of workshops conducted by their teaching peers and/or professional consultants. During the first two days of the institute, participants had the choice of attending laboratories designed to teach them the basics of operating computers, video or laser equipment. Workshops also introduced the teachers to a variety of imageware and software, including Hypercard. These activities were conducted by outside consultants.

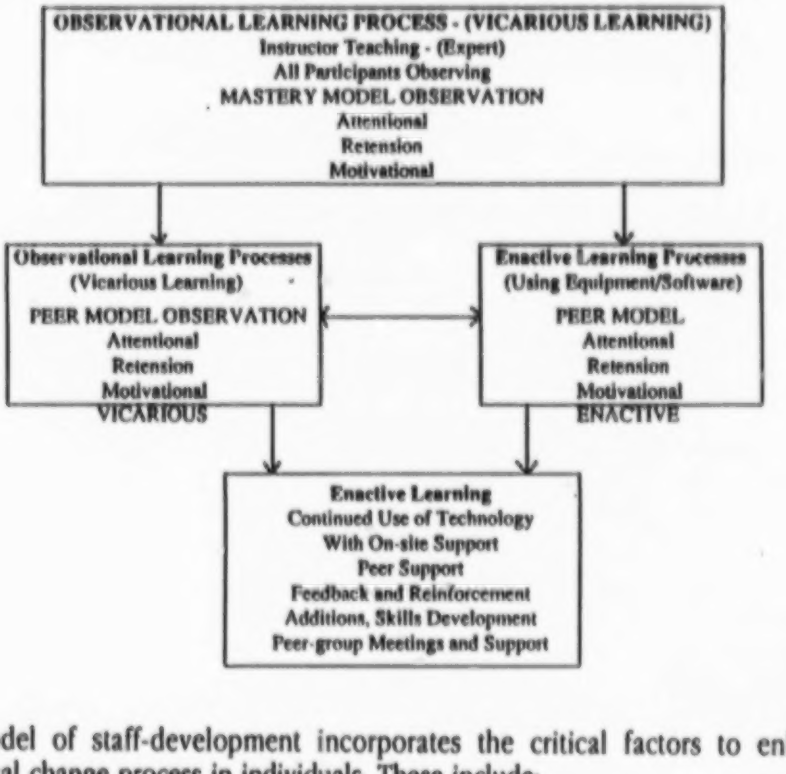
2. **Enactive learning process** - Following the observational activities, the teachers were grouped together by departments for the next two and a half days. Their task was to develop a technology based presentation of their Department Technology Plan (DTP). The DTPs had been developed the previous spring. The DTPs reflected a consensus of all department members on the goals for the use of technology and specific objectives that all members would accomplish.

   To develop their presentation, each department had access to a variety of equipment and software as well as to the experts on hypercard development, laser use, and video production. The participants developed storyboards, assigned roles, and worked together to gather and develop the resources necessary to develop their presentation. Consultants were available as needed to provide technical expertise. This phase of the institute provided an unplanned bonus in that departments developed a rapport and collegiality that had not been predicted. For many participants, this was the first time they had to work and plan together in a meaningful way.

3. **Observational learning process** (Vicarious Learning, Peer Modeling) - Incorporated in both stage two and three of the intervention. On the fifth day of the institute, each department presented their Department Technology Plan. Presentations were made using video, interactive laser discs, and Hypercard stacks. Each presentation demonstrated the high degree of peer interaction that had been necessary to accomplish the task. Peer support was also provided and demonstrated by the positive comments and supportive statements made by other staff members. This renewed sense of "team" and peer interaction has carried over into the regular school year. Department and regular staff meetings reflect greater time for curriculum and student planning in addition to management items.

Figure 1

TECHNOLOGY TRAINING MODEL FOR COGNITIVE CHANGE


OBSERVATIONAL LEARNING PROCESS - (VICARIOUS LEARNING)
Instructor Teaching - (Expert)
All Participants Observing
MASTERY MODEL OBSERVATION
Attentional
Retension
Motivational
Observational Learning Processes
(Vicarious Learning)
PEER MODEL OBSERVATION
Attentional
Retension
Motivational
VICARIOUS
Enactive Learning Processes
(Using Equipment/Software)
PEER MODEL
Attentional
Retension
Motivational
ENACTIVE
Enactive Learning
Continued Use of Technology
With On-site Support
Peer Support
Feedback and Reinforcement
Additions, Skills Development
Peer-group Meetings and Support

This model of staff-development incorporates the critical factors to enhance the conceptual change process in individuals. These include:

1. **Motivation** - Teachers were involved in a high visibility project and had personal goals to accomplish. Professional credit was provided for completing the inservice training. Accountability at the end of the training session was demonstrated with a finished product that was useful to them in their classrooms.
2. **Attention** - Implementation of the skills to complete individual and departmental tasks demanded the participants attention.
3. **Retention** - Actively engaged on a project that had personal meaning and importance increased their retention of the training through practice and reinforcement.

4. **Motor Reproduction** - Performance of the tasks and the use of the technological equipment, not just observation, helped retention and meaningful learning.
5. **Use in a Natural Setting** - Training was conducted in a normal classroom context. The product the teachers developed was directly related to their classroom teaching.
6. **Feedback and Reinforcement** - An on site "expert" was available to each of the groups during the production of their demonstration lessons. During the early stages of the institute, the "experts" demonstrated and provided instruction on the use of the equipment and the software the teachers needed to use to complete their project. After the initial instruction ,the "experts" assumed the role of the "guide on the side" and provided feedback and reinforcement to the individual groups. The product oriented training used heterogeneous cooperative learning groups. The groups were composed of teachers in the same subject areas with variations in individual knowledge of computer and technology use. This combination of strong and weak users enhanced the stronger users understanding because the stronger individuals explained/demonstrated the function of the equipment and/or software which further increased their level of understanding. The weaker user was able to benefit by having immediate feedback (i.e., instruction, praise, correction) from a peer and yet was able to contribute to the production of the final presentation.

An unexpected outcome was a feeling of collective efficacy towards the goal of school-wide technology implementation and teacher confidence in the ability to change. This positive feeling of efficacy is supported by the following comments made by staff:
"I'm excited to come back to school. There is so much to learn this year."
"In twenty-five years, this is the most excited I've ever seen a school staff prior to the beginning of school."

APPENDIX A

The state of California is funding Model School complexes through five-year grants of $500,000 a year to five school districts, each involving a high school and feeder schools. Each district is a microcosm of California's demographics. The project goals of Model Technology Schools are to:

- demonstrate instructional technology use that supports state curriculum and instructional objectives;
- develop models for training teachers and administrators;
- support and disseminate research on instructional, administrative and home-school uses of technology;
- promote and field test the development of new technology products;
- determine facility standards required for using computer, video, and interactive technologies in both new and existing schools;
- disseminate results of the project to decision makers and other educators.

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INTERNATIONAL COOPERATION IN CAL: A BOTTOM-UP APPROACH

Peter Williams*

ABSTRACT

MEDC at Paisley is the Scottish Centre set up to provide training and develope course materials in the new technologies for Scottish post-school education.

We have built up a network of cooperating institutions in other countries with whom we exchange software and course materials. The agreements often depend on the enthusiasm of individuals, and a focus was needed to bring these talents and energies together.

The solution was a two week International Workshop on New Technology Course Materials held at MEDC in the summer of 1988. The participants came to work not to talk. Some had limited resources or support in their host institutions; others were experienced workers. The cooperation created new course materials, new partnerships and new confidence. The CAL materials to be described are already in use, and the cooperation is actively continuing. We commend this approach to other institutions.

INTRODUCTION

MEDC was set up by the Scottish Education Department to provide training in new technology topics for staff from Scottish colleges and universities, as well as for industry, and to develop relevant course materials. In meetings with staff from institutions in other countries we had been struck by a pattern. There were a few institutions where large-scale funding had made it possible for groups of workers to concentrate on the production of CAL software. There were many colleges and universities were one or two dedicated individuals were producing work of great value. They were frustrated, perhaps by the lack of resources, but even more so by the lack of contact with other workers in the field.

There had been seminars and conferences which attempted to bring such individuals together and they will continue to be necessary. They are not enough.

THE WORKSHOP

The idea was conceived of bringing these individuals together to create CAL and other learning materials cooperatively. This would take place over a relatively short period because of the inevitable time and cost constraints. The result was an International Workshop held at MEDC from June 27th to July 8th

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1988. The Workshop was attended by 28 participants from 12 countries in addition to the Scottish contingent. All told, over 60 people took part in these activities. The countries represented were Norway, Sweden, Finland, Netherlands, Germany, Yugoslavia, Jordan, England, Scotland, Nigeria, India, Hong Kong, Seychelles and Australia. There were project groups on authoring languages, interfacing, expert systems, mathematics teaching, the transputer, spreadsheets, hypertext and desk top publishing. The resulting CAL and other materials are free to all participants, who have the right to distribute them as they wish within their own countries.

THE PARTICIPANTS

In some cases members of groups were working together for the first time during the two weeks of the Workshop. In a number of instances individuals had been in contact over the previous months and had already developed preparatory materials. Some groups were particularly well prepared, in that funding had been obtained for members to participate for a number of weeks prior to the Workshop. Cooperation has continued since that time and a number of new packages have been developed.

Because of the very different levels of experience of participants, there was a strong element of self-training within the Workshop. They were all, regardless of their experience, enthusiasts. Those who were skilled gladly gave their time to bring their colleagues up to a productive level in a remarkably short period. This paper reports on the results of the Workshop and on the mechanisms by which it was established and run. The process is at least as important as the products.

In an ideal world we might not need such methods. Funding agencies would recognise the importance of CAL and set up full-time teams of software authors and give them adequate access to teachers and researchers. In our very real world, such a Workshop offers a new way of harnessing the energies and talents of those individuals who would otherwise become inhibited, even intimidated, by their isolation.

THE PROJECTS

Hypertext

The project used Macs to create a learning package, using hypertext techniques to teach how such techniques might be applied within the educational process. The group had members from Finland, Sweden, Netherlands and Hong Kong, as well as from the UK.

Mathematics

This group focussed on the teaching of matrices at first year undergraduate level, combining Turbo Pascal with Mosaikk a

Norwegian developed graphics environment. The members were from Norway, Seychelles and Nigeria as well as from Scotland.

Expert Systems
The group worked mainly in Turbo Prolog to create an expert system shell. The target is to integrate the shell with the interfacing work to provide intelligent real-time tutoring in the laboratory environment.

Transputer
This small group is in the process of completing a video on the principles and applictions of the transputer chip, and had staff from Scottish institutions.

Spreadsheets
This group of Jordanian Government education supervisors were in Scotland on a training programme for computer technologies in secondary schools. They investigated the role of content-free software in schools.

Interfacing
Preparatory work had been done on a package to simulate on screen a collection of instruments and display devices, and to interface them to external hardware through the ports of the microcomputer. This package in 'C' has been completed and a revised version has been written in a different dialect of 'C' to accommodate other display standards. The second package also in 'C' provides a graphics interface to simplify setting up a data table for configuring the hardware. The participants came from India, Yugoslavia and Scotland.

Desk Top Publishing
This small Scottish group evaluated ways in which the DTP environment could be used to produce standardised course material layout and various stylesheets have been prepared.

Authoring Languages
We needed an authoring language that could be freely distributed, with full access to the source code for integration with some of the other packages being developed. The group, with members from Australia, the Netherlands, Germany, England and Scotland, produced a pilot version, currently being re-written in 'C'. It was based on authoring tools previously developed by one of the members.

SUMMARY

A substantial body of material has been produced in the form of software and documentation. The standards are good. Inevitably there are many gaps and MEDC has taken on the task of filling them and preparing the first issue to be sent to all participants at the Workshop.

The Workshop has been an outstanding success and we have made partnerships and friendships which will extend for many years. We most of us felt that we had achieved more in these 10 or 12 days than we would normally have done in as many weeks. The cooperation has not stopped. Several groups are still sending new materials to each other and testing the originals. A second workshop will be held at MEDC in the summer of 1990 and there will be regional activities by various institutions in the meantime. Cooperation on a bilateral and wider basis is assured and we can commend this cooperative approach to the production of CAL materials to any other interested parties.

ACKNOWLEDGEMENTS

Thanks are due to the Scottish organising committee, the many institutions involved and particularly to the Committee on Science and Technology Education in Developing Countries (COSTED) for their sponsorship of participants.

KEY ISSUES FOR EDUCATION IN THE INFORMATION AGE: LESSONS FROM STAR TREK

Angela Smith*

ABSTRACT

Computers seem a natural in training young people to become citizens in the information age. Yet despite the proliferation of small computers in our schools, the emphasis seems to have changed with computers being used more as a topic of instruction rather than a technology to improve or to make more efficient instruction in basic subjects.

The need to produce a computer-literate generation is still a major challenge not only in the United States but in most countries of the world. People must be trained in the way computers and related technology can make them more effective professionally and personally. School leaders are also challenged to increase their own productivity as professionals in the educational process.

Unless small computer technology is integrated into the mainstream of school operations, the new technology may become a competitor rather than a helper. Most important, the computer must be recognized for its ability to improve the individual instructional process.

INTRODUCTION

Education . . . a new frontier.
This is the voyage of technology for learning
Its mission: To explore new ways of teaching, to seek out new software, new delivery systems, compatibility. . .
To boldly go where no computer has gone before.

If it sounds a little like Star Trek, the similarity is deliberate. Like Captain Kirk, Mr. Spock, and all the rest of the intrepid crew of the original Starship Enterprise, the visionary educators who took those first steps in the computer revolution in schools were exploring uncharted territories. They knew that what they were accomplishing could make a dramatic difference in education and could, in fact, change the face of tomorrow's classroom.

That was back in the late 70s and early 80s when the personal computer came into its own.. At home, office and school -- those darlings of the technological revolution,

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those ubiquitous little miracles of modern man were everywhere and an Apple a day had nothing to do with doctors unless they happened to be computer enthusiasts. Even Time Magazine threw in the chips, so to speak, and named a personal computer its Man of the Year.

That was 1983. Now, six years later, the commotion has died down. The dust has settled literally on hundreds of computers sitting idle on shelves of school storage closets or on tables in back corners of classrooms. Teachers who felt threatened that technology and computers were going to replace them have relaxed, no longer feeling their jobs are in jeopordy.

Despite those who say the revolution is dead, the use of computers in education is still as popular as ever. Districts each year are still spending millions of dollars on small computers. Others plan to make major investments in the near future in computer hardware, operating systems and applications software. The question is: is that investment being used to the best advantage? And are the people making those investments making them for the right reasons?

THE CHALLENGE

The transition from industrial to information age continues. Each day we find new ways to use technology, thus increasing the demands on education. To address this challenge, schools have already added to their repertoire of basics, computer literacy. But beyond teaching the obvious, that is technical aspects of operation and how a computer works, schools are also faced with the task of training a new work force for an information oriented, communications based society.

The need to produce a computer-literate generation has never been greater.. World leadership will be determined by those nations who make best use of technology and who can develop strategies to develop and maintain a technically trained work force for the next century.

If we expect to survive in this increasingly competitive world, it is crucial that we understand technology, that we know how to use it, and that we appreciate its potential benefits. That means not being fearful or intimidated about its use. That means going beyond teaching the basics of how to use a computer to being comfortable with technology as a process for making us more effective and productive, personally and professionally.

How America fares in tomorrow's world marketplace is being determined in today's classrooms. For that reason, it is imperative that we begin to transfer knowledge into application that is practical and useful. Curricula must move beyond the existing technical format to providing relevant educational experiences--experiences that will produce the human resources needed in our country to develop products more efficiently and effectively.

The computer in today's classroom is too often relegated to the position of just one more teaching tool, just one step above the overhead projector. In 1981 New York computer consultant Eileen Gress accused the educational system of using computers to promote assembly line learning. According to Gress, the computer was used for little more than spitting out drill and practice problems by the dozen and creating countless reports that were seldom used effectively.

Things haven't changed much since then. Her call for a restructure of the curricula, to search for better ways to reach old goals, and to define new goals and new ways of learning still holds true today.

THE NEED FOR A NEW APPROACH

With projections of computers being in most homes in a few years and with the growing demand for training in computer technology in the job market, computer literacy becomes more crucial. It has already become a political issue at both state and national levels, evidenced by computer literacy programs now mandated in several states. Most of these mandated programs are traditional in concept, concentrating on giving the student a basic knowledge of computers, their use, history, and simple programming. The need now is to move away from the drill and practice routine that still dominates the curricula and to take an multidisciplinary approach, giving students the opportunity to use the computer in new ways and in new environments.

Curricula should be rethought and redesigned to develop knowledge that will enable students to be problem-solvers and decision-makers, able to generate new knowledge and control situations. Certainly in the area of problem solving the computer can have its greatest impact.

The present emphasis on acquiring information must be changed to learning how to learn. Rather than teachers teaching subject content, they must begin to teach students how to teach themselves.

Much stress has been placed and continues to be placed on producing "user friendly" equipment. Perhaps, it's time now to change that emphasis to producing a population that is "computer friendly," a society that will be able to use technology to its best advantage, that will be completely comfortable and at home with its use.

As one who's resisted the onslaught of technology into my own life, I relate to this on a personal level. My field is communications, and I confess I am a victim of those dreaded diseases known as techo stress and computer phobia. It's been a slow, often painful process, but I find myself gradually becoming less intimidated by that small screened monster which faces me daily. I have even been known to occasionally mutter a silent word of thanks for the wonders of word processing. I may never be completely comfortable with this technological world I am forced to live in, but at the same time I'm glad we've moved beyond the manual typewriter, which was my main tool of the trade as a novice news reporter in 1969.

There's no reason students today should ever suffer this handicap. They live in a world where computers are commonplace. They have no reason to ever be intimidated by the technology that surrounds them. It's our job as educators to make certain they use this knowledge to become more productive citizens in a technologically-based society.

The original Star Trek television series was revolutionary for its time. Now the producers have come up with a successful sequel. Education, as far as technology goes, is still a new frontier. It's time we took a hint from Star Trek, and produced a new generation.

THE ENABLED PERSON: INFORMATION TECHNOLOGY AS A MEANS TO AN END

John C McCann*

ABSTRACT

The UK's Department of Trade and Industry defined 1982 as Information Technology Year. A major programme within this year, and following on from it, was 'The Concerned Technology' - extending the application of the new technology to those with special needs. This paper describes the projects covered by The Concerned Technology initiative, and shows how they led to a concentration on a single education project - for Home Delivered Training (HDT) in Information Technology Vocational Skills. As well as describing HDT, the paper aims to encourage a broad approach to technology application: only by scattering sufficient bread on the water can the true value of technology to those with special needs be identified.

INTRODUCTION

The United Kingdom's Department of Trade and Industry was quick to identify the potential of Information Technology in the early 1980s: we were the first country to have a Government Minister with sole responsibility for IT, for example, and microcomputers were provided in all British schools in advance of other countries.

The 'Concerned Technology' programme - subtitled 'Information Technology for those with special needs' - was set up as part of an awareness campaign aimed at all sections of the community. Under it, we sought to support companies applying the new technology to provide goods and services for people with disabilities, and we sought also to reassure the general public - pre 1984 - that a new technology combining computing and telecommunications did not necessarily carry Orwellian overtones.

In most cases, the Concerned Technology programme involved purchasing pre-production or early production models from manufacturers (often very small companies), and placing them with users for evaluation. We worked in three principal areas - in education, rehabilitation and employment - and I should like to describe each in a little detail. In doing so I hope to make the point that all applications led to a demand for better education and training, and all led to the person with a disability becoming less restricted by his or her disability. IT is an 'enabler' - hence the title of this paper.

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EDUCATION

The DTI backed many computer projects for those with special educational needs. The aim was to see where technology could be applied to create an environment in which young students could develop their intellectual, social and occupational skills to their fullest potentials.

With younger children, and for those with learning difficulties, the 'Turtle' proved a stimulus and motivator. The device - devised in the US and further developed in Edinburgh - can be used to draw geometric shapes and introduce mathematical concepts. It was one of a series of classroom aids - in hardware and software - that proved to be of immense value.

For the physically disabled student in Further Education, personal computers helped overcome the problems associated with taking lecture notes or writing essays. Students given exclusive use of a work-station were able to concentrate on the substance of education, not on its mechanics.

In these and many other applications with a wide variety of groups - including the vision and hearing impaired - IT made a positive contribution. It became part of the fabric of education: a part that, logically, had to be sustained.

REHABILITATION

Among applications in the 'health' sector, I should like to refer to work with spinal injuries patients. We suspended keyboards and monitors above the beds of patients during the long weeks immediately after the accident, when they have to lie flat to allow healing to take place. We found that not only did the computers prove a diversion and an interest, but they stimulated discussion in the hospital wards: patients had a shared interest to discuss other than their reasons for being there.

Occupational therapists found there - and in applications elsewhere - that computers are valuable in stimulating patients to practice manual skills and mental skills.

A natural corollary to this work was the creation of a computer workshop at Stoke Mandeville Hospital: patients have been quick to recognise that, as well as therapy, the computer gives the prospect of meaningful employment. Of the first 100 patients to undertake training, 52 had bought their own computers within one month of discharge from the hospital.

EMPLOYMENT

The concept of remote working - or teleworking - is becoming widely discussed now in the UK. We recognised its value six years ago for people with physical handicaps, and set up 100 remote work units throughout Britain and Northern Ireland.

A wide mixture of people were matched with a great variety of employers: the DTI provided the computer equipment, gave consultancy support and monitored the results. It was an ambitious task and many lessons were learned - including the needs for distance learning and the problems of remote management - but overall the experiment was so successful that there is now a national provision to help those with physical handicaps to work in this way.

HOME DELIVERED TRAINING

One of my main areas of activity now is with a project called 'Home delivered training (HDT) in information technology vocational skills'. I hope you will see how it naturally followed from our previous work.

HDT is a three-year study to determine whether open learning methods can enable people to learn computer-based skills at home that will equip them for employment. It is directed to people confined to home for reasons of disability, because they are caring for others, or because they live in remote areas where attendance at a conventional place of learning is impractical.

What we have done is to place business standard computing equipment in about 60 homes, and provide a distance learning course based on a carefully researched blend of the best - and most complementary blend of - software and courseware. In 240 hours study - with some trainer support - we are finding that trainees are sufficiently adept in general computer functions, and in specialist options that they may select, that they are finding rewarding employment in jobs they could not have even considered previously. For employers, this is also a part of the solution to the UK's IT skills shortage.

SUMMARY

In a variety of applications under the Concerned Technology umbrella, IT has stimulated people with special needs. Such people have gained interest after accidents, have improved in education, and have had the confidence and the skills to go out to get meaningful, demanding employment.

The long-term use of the computer is invaluable to them as a tool. But the machine is only the means to an end, not an end in itself. IT is the enabler that allows personal qualities to flourish.

COMPUTER ASSISTED INSTRUCTION: SOLUTION TO THE EDUCATIONAL CRISES OF THE DEVELOPING WORLD

R.J.GREEN*

ABSTRACT

The demand for education in developing countries is found at all levels--primary, secondary, and tertiary--because it is perceived to be the route by which a higher standard of living can be achieved. However, those governments are facing crises in the areas of facilities, trained personnel, and student achievement as they attempt to meet the demand. Preliminary research has indicated that computer assisted instruction (CAI) has potential for alleviating these crises, for no other medium can presently be found which provides such a wide range of learning experiences with compactability and versatility. It can provide cost-effective assistance to crowded classrooms, introduce neurolinguistic aspects of learning into the student's experience, and address the diagnostic, remedial, and cognitive needs of students. The development of a low cost computer, with basic specifications, is suggested. In addition, software which is tailored to the environmental influences from which the students come is recommended.

INTRODUCTION

Within the developing countries there is a great desire for an education so a diploma or degree becomes a strong motivating factor. This desire comes not just because of status-seeking impulses, but from the realization that standards of living improve as the level of education increases. With the diploma or degree comes knowledge which has potential for addressing the problems of life that interfere with a higher standard of living.

Currently, the developing countries face three major crises in providing education for their populations. The first is lack of facilities in formal education for accommodating those who desire to learn. It is not unusual in many schools to have 50-70 students per classroom. Such a high student-teacher ratio does not permit satisfactory development of certain educational skills.

A recent study by Olembo (ref 1) reveals the crisis proportions of this problem. For example, Kenyatta University, responsible for teacher training in Kenya, has been operating at the budgetary level of 1985, though demand for teachers has tripled since then and is expected to double again by 1991. With limited financial resources to meet the increasing demand for teachers, the inevitable result is going to be increasing populations per classroom.

The second major crisis is a lack of competent personnel for teaching the many who desire to learn. In order to accommodate the large number of

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students, the teachers employed often are not sufficiently trained to provide their students with adequate academic direction. One large pool of personnel utilized for relieving this crisis consists of students who have been unable to complete satisfactorily secondary school and thus fail to qualify for university entrance.

A vital component of student performance is concerned with the neurolinguistic aspects of learning. Torres and Katz (ref 2) feel that when this is present in the classroom academic improvement can be expected. Teachers with insufficient training usually lack sensitivity to this component. Teachers who have been unsuccessful in completing secondary school have exhibited prima facie evidence that they have failed to implement the neurolinguistic aspects of learning.

The third major crisis is an outgrowth of the first two mentioned and is the inability of teachers to provide sufficient individual assistance in most of the classrooms in developing countries.

Individual students have either a relational or analytical cognitive style, and Gardner (ref 3) found that an individual's cultural background is an important factor in determining which style the student uses. Students in developing nations seem to have an environment which encourages adeptness with the relational, while formal education requires an analytical approach. An untrained teacher is often unable to address this cognitive mismatch. Efforts need to be implemented to help students move from a relational approach to greater comfort and skill in utilizing an analytical style.

COMPUTER ASSISTED INSTRUCTION

A CAI component could be utilized efficiently in dealing with each of the above crises. The effectiveness of CAI is now relatively unchallenged. It can provide the school with more assistance in promoting student achievement where the student-teacher ratio is high. It could be used for providing both diagnostic and remedial assistance in schools where teachers may not have sufficient training. CAI could be utilized for assisting students in a more individualized format than is now possible in most schools.

Preliminary research has been carried out in the Skills Improvement Laboratory of the University of Eastern Africa to determine the feasibility of CAI in the average Kenyan classroom. Several important conclusions have been reached. They are:

1. A student-computer ratio can be achieved, through CAI planning, permitting a realistic class population for achieving the most cost-effective academic assistance.
2. With CAI's potential for utilising neurolinguistic aspects, significant academic improvement can be achieved within a short time span.
3. Software can be developed which will address the diagnostic, remedial, and cognitive needs of the average student.

The development of a low-level (performance and price) computer appears to have potential for supplementing cognitive development and enhancing academic achievement in developing countries.

SPECIFICATIONS FOR A LOW-LEVEL COMPUTER

The envisioned computer should provide exposure to a variety of experiences in the tactile, visual, logical, and perceptual areas which are necessary for cognitive development. For efficient cognitive development in a school situation more structured learning experiences are needed. The computer should be able to provide these experiences at a satisfactory level of intensity in a succinct, concentrated, and prescriptive manner in addition to meeting the underlying requirement of cost-effectiveness.

Further specifications include:

Size - As small as possible without sacrificing accessibility to components for ease of servicing. If obsolete components require a larger size that would be acceptable.

Screen - Liquid crystal or CRT with low power consumption. No smaller than 8" x 6".

Power - Can operate with either 12-volt automobile batteries or 220 volts AC.

Manufacture - Either fully assembled or in kit form which can be assembled by an average person without schematic-reading skills. An average person can be trained to assemble. It would probably be best if PC boards were already stuffed. If cost of case would be significant, then it could be supplied locally.

Peripherals - Any standard cassette recorder could load or receive dump--though not a high priority from a cost perspective.

Keyboard - Standard-size QWERTY, 53+ alphanumeric keys.

Language - Basic.

RAM - 32K (approximately).

I/O - Programs would be put into a programmable chip. The desired program chip would be supplied to the participating schools. When a different set of programs were required, the school could return its chip and have it reprogrammed. If beneficial to a lower cost, the computer would not need to be keyboard programmable.

Microprocessor - Z-80 8-bit processor. Clock speed, 2.03 MHz; or, 6809E 8-bit processor. Clock speed, 0.894 MHz; or, two 4-bit CMOS (one for arithmetic operation, one for BASIC interpreter and key-in); or, 8-bit custom CMOS. Clock speed, 1.3 MHz.; or etc.

Components - Off-the-shelf or obsolete.

Software - (1) Tutorial, (2) Low-level diagnosis for identifying areas of student's learning problem, and (3) Assisting relational/analytical style shifts.

Price Range - US$ 150-200 retail to the school.

All specifications are negotiable based on cost-effective factors such as durability, processing capability, and technology and components available.

An alternative to the specially designed unit specified above would be any obsolete, or end-of-stock units. Continuing orders would not have to be filled by the same equipment as previously supplied--only that they do not fall below the above specifications (other than the programmable chip requirements which could be replaced by disk if that was available on end-of-stock units).

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Project SUCCESS - An Inner-City Partnership

E A Flinn *

ABSTRACT

Project Success is a unique initiative which brings together industry, schools and higher and further education in the Greater Manchester area with the aim of altering the self-image of inner-city schoolchildren, and their attitudes to education and employment. Like many inner-city regions in Europe and North America, the area is one of high unemployment, with attendant sociological deprivation, and Project SUCCESS aims to attack some of these problems at their roots. The wide significance of the project has been recognised by the award of funding from the European Community, to seek out a partner-city or cities in Europe for the international exchange of experiences and ideas.

BACKGROUND

The twin cities of Salford and Manchester were prominent in the first industrial revolution, and in the 19th Century the area experienced an explosive growth in population and prosperity. In recent decades, however, the story has been one of continuous decline, and the area now suffers from the problems common to the cradles of smokestack industries throughout the Western world. Adult employment is extremely high , with almost one-third of adult males unemployed in the central areas. The juvenile unemployment figures have been much lower, owing largely to major government programmes, such as the Youth Training Scheme, which have targeted school-leavers. Unfortunately, there is evidence (ref 1) that such schemes have simply disguised the true state of affairs, and that because of their low educational standard, the employment prospects for today's inner-city school-leavers remain poor, in spite of the fact that the population in this age-group is falling very rapidly and will continue low throughout the remainder of this century and beyond (refs 2 and 3).

This background of adult unemployment and social deprivation, together with the prospect of a lifetime of at best intermittent work in casual or dead-end employment, means that schoolchildren see little value in education, either at school or in later life, that their view of industry and commerce is extremely negative, and that their perception of their own worth is low.

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THE PROJECT

The project aims to change the mind-set of schoolchildren in the inner city, improving their self-image and changing their view of the world of employment and post-school education, and of their own place in that world. No one institution or sector of society can single-handedly achieve such an ambitious task, and Project SUCCESS will bring together industry, higher education, and local education authorities in a combined effort.

Compact schemes, of the type already familiar in the U.S.A., exist also in Britain, and indeed the University of Salford is already a partner in such a compact with industry and the local city schools. However, the aims of a traditional compact are very specific, and rather limited. Project SUCCESS can be regarded as an extension of the compact principle to wider and more ambitious ends. In particular, the involvement of higher education (i.e. the university and polytechnic sector) in such a scheme is novel for the U.K., as the various sectors of education have traditionally been rather isolated from one another.

The University of Salford is peculiarly well suited to pioneer such an activity, since its history and its strategy over the past decade have made it quite different from most other British universities, which have continued in their traditional roles. Salford is small, composing in all about 1% of the British university system, so that it can behave much more flexibly than is possible for a larger institution. However, we have a relatively small number of large departments, so that we are particularly strong in technology, science and applied modern languages. We also have a very extensive involvement with industry and commerce, and both the public and private school sectors, at a variety of levels. In this we are possibly more like an American university than any other British establishment of higher education, and it is these non-traditional attitudes which have allowed us to take the lead in Project SUCCESS, with its emphasis on enterprise and personal development.

Interaction between industry, schools, the university and local colleges of further education will take a variety of forms. Possibly the most important element of this interaction will be the involvement of students from further and higher education with the work schoolchildren. Again, this element is not new; it has been used in the U.S.A. and the U.K., and was in fact originally proposed in the Eighteenth Century.(ref 3).

Student tutors have in the past essentially been volunteers, and tutoring has in general been an extra-curricular activity. In the Salford scheme, tutoring local school students will be an integral and assessed part of the undergraduate course as an option on the Graduate Enterprise program. It is clear that the whole-hearted support and collaboration of business and industry at both the national and local level will be crucial to the success of the project, and staff from local and national enterprises will be involved, helping with school projects. University and college students too will collaborate on such projects, so that all will benefit in a way not possible with a purely two-way link.

The direct help given to schoolchildren by students will of course be valuable, but more important will be the unconscious effect on children's attitudes produced by continuing personal familiarity with students. Most inner-city schoolchildren lack educated role-models among their family and acquaintances, and we are confident that this interaction with students will be of great value in helping children to see post-school education as a real and valid option for themselves. Similarly, the interaction with real-world representatives of business and commerce will give them a better idea of their own value to such enterprises.

Although the University has no Department of Education, and carries out no initial teacher training, staff of the university have for many years supported schools education in science, technology and management, by means of in-service teacher training and curriculum development. This work will be extended and broadened to give greater in-school support, and children will be brought into the University's laboratories to make use of facilities more extensive and up-to-date than can be found in even the best-equipped school. The University possesses two mobile training workshops, equipped to train staff from industry and education in the fields of technology and information technology, and these also will play a prominent part in the project. Particular attention will be paid to developing among school students the skills of team working, so important in real life, but so neglected in the traditional educational process. The University has considerable experience in this field, and indeed almost the entire undergraduate programme of Salford University's I.T. Institute is based on team activity.

The University will also offer an 'access' scheme to students from disadvantaged backgrounds, extending its already wide range of access provision.

Few of these elements are new, but their combination, and the whole-hearted involvement of an institute of higher education, make the project as a whole unique, at least in British terms. The lessons to be learned from the successes and failures of the project will be of value throughout the U.K., and can be expected to be transferable, to a large extent, to almost any inner-city environment in the developed world. The project has aroused national interest, and is being supported by government ministries, national and multi-national businesses, and by the European Community.

The aims and ideals of Project SUCCESS encapsulate the new spirit of enterprise and independence now abroad in the U.K. We look forward to learning many new lessons, and hope to collaborate with people in other cities and other countries who share the same problems, so that we can share mutual support and a continuing exchange of ideas.

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PUBLIC ACCESS FOR PERSONAL EMPOWERMENT

A.Stone

ABSTRACT

The potential for technology further to divide society is enormous. The situation is clear: some people can have computers at home, others can't; some schools can have computer labs, others can't. The *problem* is not so clear, but becomes more evident when one considers a few current facts of life:

- It is now necessary to have a high school diploma in order to be accepted for military service.
- At least one major US corporation screens its applicants for employment through their answers to the question, "What is your computer experience?"
- The recent NAEP report on computer competence among school children found that those who know most about computers learned most of what they know outside of school.

The implications are obvious. Access to computer-based technology must be made available to out of school people. Ways must be found not just to use the computer as a drill master to increase basic skills among the undereducated, but to introduce all people to the power of the computer to help them fulfill their own life and learning needs.

For almost six years, Playing To Win has been offering the residents and service agencies in East Harlem, a low income neighborhood of New York City, access to a variety of computers. The Playing To Win Computer Center, situated in the basement of a housing project building, serves over 500 people, aged 3 to 93, each week. Participants choose among hundreds of pieces of software and can use any of thirty computers of six different makes. The Center is staffed with three teachers and is open six days a week. The emphasis is on computer tools, enabling people through technology.

After outlining briefly Playing To Win's experience, the presentation will examine some of the obstacles in the path of community computing and give examples of how these may be overcome. These topics will include funding, staffing, security, program, outreach, and evaluation. Questions from attendees will be welcome.

Playing to Win, Inc.

BOOTING UP READINESS FOR EARLY LEARNERS AT RISK

TRISHA AINSA, Ph.D.

The developmentally appropriate content areas of early childhood education were the focus of this study including: cognitive development, socio-emotional development, language development, and motor development. The appropriate hardware and software to enhance each area was introduced with specific examples and directions for integration. Handouts, example lessons from language, reading, and social studies, plus a software list for content areas (available for presentation attendees) are based on survey recommendation responses (included) by early childhood teachers. Implications for at-risk children utilizing a computer in the classroom to enhance developmental and academic skills are discussed. A report summarizes the results of computer intervention in at-risk classrooms. Data was collected measuring content area, mastery and English language proficiency of participating students in Head Start facilities. Statistical results indicated significant differences in treatment groups.

Review of Research

Early childhood educators became interested in computers as they recognized the potential for creative thinking and interaction. Papert (1980) thought that the use of computers could help children's problem-solving skills. Parents watched television commercials that touted the computer as the first step to success. Child care centers advertized the use of and instruction in computers as a bonus feature. Anselmo and Zinck (1987) researched computing in early childhood and urged early childhood teachers to identify the skills that they wished to promote first, and then evaluate software based on its appropriateness for young children. Woodill (1987) examined the use of computers and summarized increasing cognitive development and motivation, and the ability to extend the capabilities of disabled children. He listed areas of caution about the use of computers with young children; including its abstract nature, inequities in use, and the values found in computer software. The author emphasizes teacher education and proceeding with care when introducing computers into early childhood education curriculum. Ziajka (1983) promotes the selection of a "friendly" computer. Choosing one that is easy for staff, parents, and children with an easy to use keyboard. A full-stroke keyboard is preferred to a membrane keyboard. Children need the full sensory and fine-motor feedback that can be felt by pushing a key completely down and feeling it come back up. Among the specific benefits of microcomputers for young children he lists: fine-motor skills, eye-hand coordination, play, drawing, imagery, imitation, symbolic representation (Piaget, 1962; 1969), and language. The control and competence exhibited by young children as they use a computer helps develop autonomy, a social need described by Erickson (1963). When children can experience gross motor as well as fine motor keyboard exercise, and participate in appropriate games, activities, software learning enhancement, and training; language experiences resulting in successful language learning take place (Ainsa, 1985, 1988).

Method

Participants

During 1987-88 program year, teachers, parent volunteers, teacher aides, and one administrator participated in college-level classes and/or inservice career-ladder credit workshops for the purpose of training in computer and language development skills in order to teach at-risk children. The trained teachers, aides, and volunteer parents taught computer literacy to to students in Head Start. Treatment groups consisted of three Head Start classrooms (N=43(Control),N=41,N=38). Children had been classified at-risk and low-income or poverty level. To enhance the random sampling procedure, all schools in the U.S./Mexico border area (El Paso County, Texas) who enrolled Limited English Proficient students of low SES and income were invited to participate. Schools that responded were automatically selected, and normal distribution was assumed. The experimental (pilot) classrooms and control classrooms were randomly assigned. The testing instrument was the SUCCESS (Screening for Understanding Capabilities of Children for Early School Success) developed by Riley (1981) to include five domains: motor, cognitive, language, self help, and social. Pre-program and post program scores were obtained in the areas of language, cognitive, and motor skills.

Program

Curriculum

Each class was given one computer, software included in the list, and educational materials. The computer curriculum was presented to the children for 20-30 minutes per day five times per week. Selected software was introduced only after developmentally appropriate introductory skills were learned.

Training:

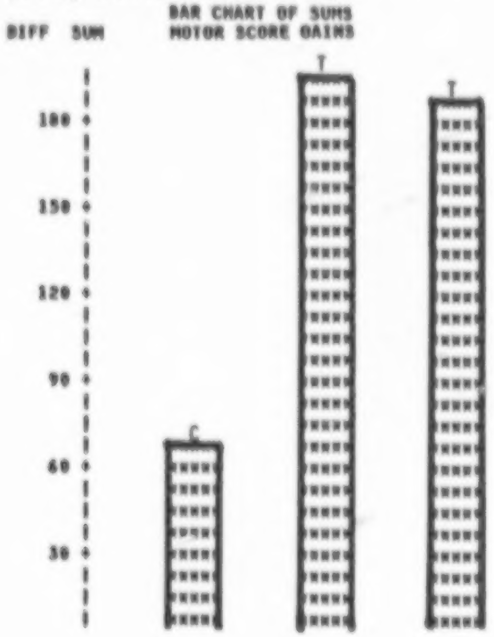
Head start teacher, teacher aide, and parent training consisted of two continuing education workshops. On-site training was also available to participants.

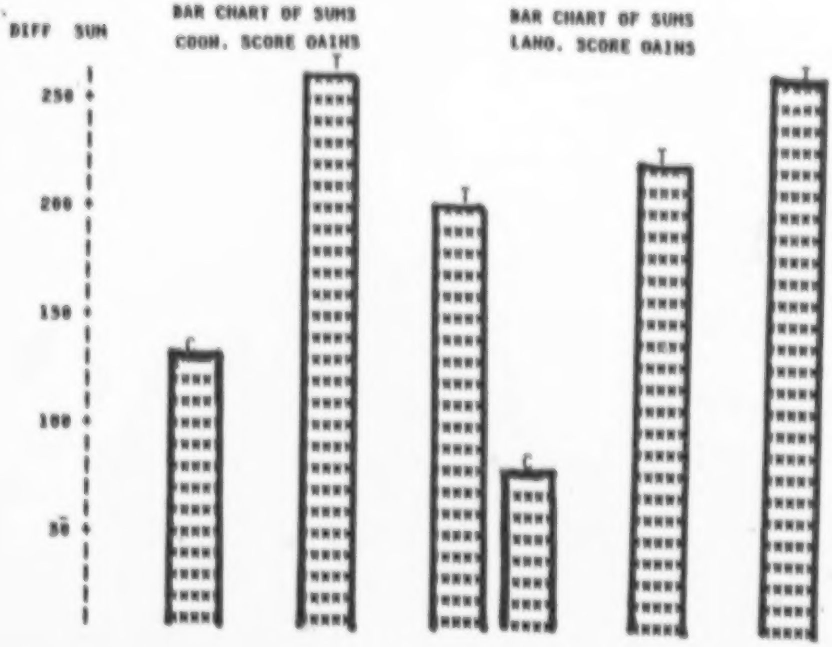
Statistical Summary

Psychological Services, La Mesa, New Mexico (Chu 1988) assisted with statistical analyses. The bargraphs present gains obtained by Head Start children in motor, cognitive and language domains. The ANOVA tests included three ANOVAs analyzing the difference between three treatment groups on motor, cognitive and language gains. The first ANOVA based on motor scores yielded $F=27.41$ ($p<0.01$, $df=2$), indicating a significant difference between the three treatment groups. Duncan multiple range test revealed that the treatment groups ($M=5.02$) and ($M=4.70$), did not differ from each other, and made significantly more improvement in motor domain than the Control group ($M=1.51$). The second ANOVA based on cognitive scores showed a $F=9.35$ ($p<0.01$, $df=2$), indicating a significant difference between the three treatment groups. Duncan multiple range test revealed that the treatment groups ($M=6.41$) and ($M=5.28$), which did not differ from each other, made significantly more improvement in cognitive domain than the Control group. Similarly, the third ANOVA yielded $F=23.09$ ($p<0.01$, $df=2$), and Duncan test revealed that all three groups differed significantly from each other, with one treatment group making the most improvement ($M=6.89$), followed by the other treatment group ($M=5.29$), whereas the Control group made the least improvement in cognitive gains ($M=1.90$).

Conclusions

Computer Literacy training created significant gains in Head Start children's motor, cognitive, and language domains. The at-risk children reached criterion level on all of the computer curriculum objectives. Teachers were particularly impressed by the care of the computers that the children exhibited. The classroom computer quickly became a reward as well as curriculum tool. The program components for early childhood computer assisted instruction, and teacher, aide, and parent training are a successful combination of activities to improve the education of young children at risk.





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A COMPUTERIZED OPEN LEARNING ENVIRONMENT TO STUDY INTRAPERSONAL VARIATIONS IN LEARNING STYLES : DELIN

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A. CONTEXT

Several studies have been devoted to interpersonal differences in so-called "cognitive styles" (Kagan & Kogan, 1970; Witkin & Goodenough, 1977; Pask, 1976, etc.). Pask himself has emphasised the notion of versatility, i.e. the individual's capacity to switch from a strategy to an other, according to changes in conditions, constrains, etc.

In order to respect both the interpersonal and intrapersonal variations in learning strategies, we have developed a software of the hypermedia type called DELIN (from the French word DELINEARISE, that means non-linear).

B. DESCRIPTION

This software offers the following facilities:

1. Management of data base files containing the stacks of "screens" (that can be combinations of texts, graphics and scanned pictures).

2. A branching table indicating the next screen the program must display according to the learner's reaction to the current screen.

3. A screen" structure pattern:
Lines 1 to 18: the screen main content
Lines 19 to 22: an empty area where the learner can write personal notes that will be given back to him/her at the end of the interaction.
Lines 23 to 24: Permanent menu buttons (described hereafter, lighted in red when available for the particular screen.
The 8 right down characters of the screen display its name.

4. Permanent menus enable to:
- (go to) NEXT screen
- go BACK to previous screen
- get more DETAILed information
- be QUESTIONed (MCQ) to check comprehension
- receive a SYNTHESIS of the content
- receive a GRAPHIC or schematic representation of the content

- receive an ICONIC or VIDEO presentation about the current content
- CALL a given screen (designated by typing its reference name).

5. A text-pointing facility:

- Each text introduced can be "boxed", i.e. each word is considered by the program as being in an invisible box. Each box can be made "sensitive or not" by the conceptor. When the user will click on a given (invisible) box, the program will react as the conceptor has decided (branching to a given screen).
- The same facility is offered for graphic data, except that the "boxing"process is not automatic: the conceptor has to define the position and the size of each box.

6. A tracing facility:
- Each student's response is recorded in an appropriate file. For instance, each click in the screen, even when it is on a non-sensitive area (that produces no apparent reaction from the system).

7. A questionning facility:
In question screens, MCQ are presented. The learner is invited to answer by pointing one of the suggested solutions. In addition, he (she) is requested to provide a confidence degree indicating how sure he (she) is about his (her) answer. The expression of this certainty (or doubt) is made by clicking one of the six areas defined on the probability scale as follow (Leclercq, 1983):

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^------------^-------------^--------------^--------^------^---^
0            25            50             70       85     95  100
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After that, the correct answer is displayed.

8. A note taking facility (in lines 19 to 22).

9. A direct branching facility : the learner may CALL a given screen by typing its name. A (paper) code book is provided with the names of all the screens.

10. Editing facilities for the author.

C. INDICES

The following indices are proportions (percentages) of the student's reactions:

L index : % of choices NEXT and BACK, i.e. of linear strategies.
Q. Index : % of requests for being questioned.
S index : % of requests for synthesis.
T index : % of pointing words in the text or (invisible) boxes in the screen.
M index : % of requests for more information.
V index : % of requests for video sequence (only in some coursewares).

D. EXPERIMENT

Two coursewares have been prepared by Pierret (1988). The first one presents Gagne's "conditions of learning" (1965), i.e. his Taxonomy of 8 categories of learning. This courseware (called TAXGAG) does not offer video sequences.

The second courseware (called TCHERNO) deals with the TCHERNOBYL accident, and a video sequence is available.

Two groups of students have been constituted: 8 students in education (university level) and 8 students of other specialities.

Two kinds of instructions have been used according to the purpose, the goal of the exercice.

In condition 1, learners were told that they will have to produce their own summary of what they have learned.

In condition 2, they were told that they will be invited to answer a series of MCQs about the content learned (assessment of knowledge condition). Additionally, some students were offered the possibility to "take notes" (by type writing).

Experimental design has been conceived so that each student has received the two coursewares and has been assigned each of the two conditions.

E. RESULTS

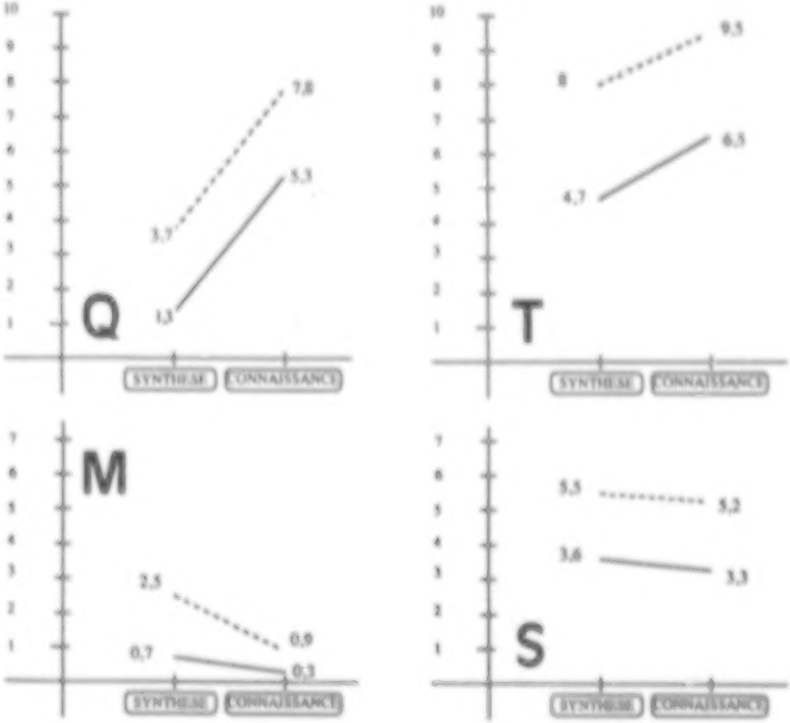
1. The L index has the highest value of all indices, for the two coursewares. This can be explained by several reasons: 1) the lack of attractiveness (and expliciteness) of the accompanying (paper) booklet containing the screens' names; 2) the lack of display showing the itinerary already achieved; 3) a students' tendency to adopt a linear strategy.

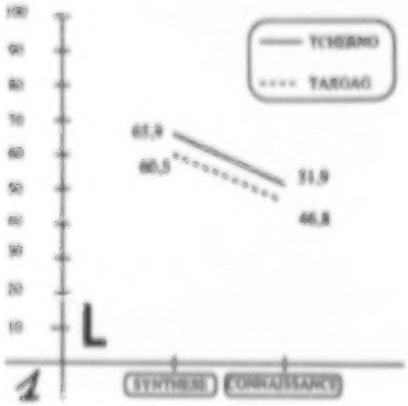
Figure 1 shows that TAXGAG has a lower L index than TCHERNO. This can be explained by the greater difficulty (expressed by the students during the interview) of TAXGAG, and, maybe, the tendency to ask DELIX for details (examples), synthesis, questions.... The same figure shows that the "assessment of knowledge" condition is linked to a lesser use of linear strategies (that means a greater use of NON LINEAR ones).

Figures show that the T and Q indices are greater for the TAXGAG courseware and for the "assessment of knowledge" conditions.

The S and the M indices, show only differences between the 2 softwares, but not between the two conditions.

There is no interaction for these indices.





E. CONCLUSIONS

Only a part of the experiment has been reported here.
The number of subjects involved is not great enough to enable us to reach statistically significative conclusions. Although they are only indicative, the results obtained support the hypotheses of intra personal variations in strategies due to external conditions. This is to be interpreted in terms of intraindividual flexibility. More evidence should have to be collected from additional experiments involving more learners and more variations in conditions, and conceived so that intrapersonal variations can be studied in the same time as interpersonal ones.

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TRAINING AT HOME: A NATIONAL PERSPECTIVE

Frits Janssen*

ABSTRACT

Various factors are conspiring to change our patterns of employment. These factors include the reducing costs and increasing power of microcomputers and telecommunications, the shortage of skills in many Information Technology-related occupations, demographic changes, increasing costs in inner-City commercial and domestic property, increasing costs of commuting, and the increased importance attached by many people to 'quality of life' issues. 'Teleworking' - working from home using Information Technology skills - is set to become much more prevalent in the next ten years, and with it will come an increased demand for home-based training - in technical and managerial skills. The technology and methodology for this is already available.

CHANGES PAST

The last ten years have seen some remarkable changes in the way we live in the Western World.

In the field of technology, for example, the much heralded microelectronics revolution has occurred with a pace and pervasiveness that not even the most enthusiastic forecasters of 1979 anticipated. The proliferation of computers and computer-based devices in all areas of our daily lives is quite staggering. The same sort of effect occurred with the introduction of the electric motor - which started as a single system at the centre of the factory floor and now numbers around 30 in my motor car alone. But that spreading of application took over a century: the computer transformation is in comparison happening almost overnight. And computers change what we do as well as the way we do things. Information Technology - the linking of computers and telecommunications - is already changing patterns of work and patterns of leisure.

Another major change, in the UK at least, is the dramatic increase in costs of domestic and commercial property. Ten-fold increases in ten years - in real terms - is not uncommon, caused in part by the congestion in our major cities. There is little solace for those living outside: commuting costs for many of us have increased by 20 percent this year already.

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CHANGES TO COME

The changes forecast for the years ahead are more society-based than technology driven. Europe is facing a 'demographic timebomb', with the number of young people entering the employment market set to fall by 30% in the UK in the ten years to 1995 - although we shall then see an upturn. Germany and Italy will see similar falls, but their numbers will then continue downwards.

For the employer - particularly those requiring staff with already short IT skills - these figures have far-reaching consequences. It is evident that employers will have to recruit more women in the years ahead, particularly those seeking work after having children. It is estimated that women will take up to 80 percent of the 900,000 new jobs on offer in the UK up to 1995. But - beyond that - the whole relationship between employers and employees will have to change: employers will have to work even harder to recruit and retain staff.

There is another factor at work here - leisure. We are becoming more committed to a burgeoning list of leisure activities. Indeed, the leisure 'industry' is considered to be one of the major engines of the future economic growth. So the employee, seeing himself or herself in a selling market for labour, is likely to opt for work that allows maximum time for leisure pursuits - and that will often mean working at or from home.

TRAINING AT HOME

For the reasons outlined, it is inevitable that training at home will grow in importance in the years ahead. Because of the pervasive nature of Information Technology, it is also inevitable that much of that training will be in (or at least using) IT skills.

There are two ways to approach home-based training - the laissez-faire approach or something more rigorous. Under the former we can say, for example, that the local high street store advertises computers with an all-in package of games and business software - so all you have to do is buy the system and work through the handbooks. That approach works for some. For the vast majority of people, however, a more effective and efficient training strategy is required.

IT World has devised and is testing home-delivered training methodology in five areas of the UK. We based it on business standard hardware and we selected ten software elements covering core elements (like word-processing and operating systems) and optional applications (like database management and desk-top publishing). The software was selected on the basis of its wide acceptance in business use, the complementary nature of its approach, and on the courseware support commercially available for distance learning. We identified 400 courseware packages, evaluated

84, and are currently using 19.

In 240 hours training, with some trainer support, we are finding that home-delivered training works: at the end of the course our trainees - unemployed previously - are getting rewarding jobs using their new-found skills: some are working at home, and some are self-employed.

The trainees come from three groups: one-third are 'carers' - often women with young children who we have seen are likely to be a major resource for employers in the future. Others (and there is an overlap between all three groups) are those living in remote areas - a pattern, perhaps, for future employees whose leisure interests need then to be near mountains or the sea. The final third are people whose disabilities make it impossible to attend a normal training college. This group, too, represents a vast intellectual resource that employers cannot afford to ignore.

POSTSCRIPT

Although many people train at home for work outside, there is likely - for the reasons covered - to be a growing number who will also want to work remotely. The discipline of home-based training is a good grounding for the discipline of working at home, and it can be supplemented with experience gained by IT World in running a national remote working experimental project. But the management of remote working is another major discipline - requiring managers who are excellent communicators and organisers, and who have an intimate knowledge of the job to be done. We have been working in this field for several years - building and testing a skills model, and producing a management guide for a central Government agency. This should be the subject, perhaps, of another paper!

POWER BEHIND THE SCREEN

John DeWitt*

ABSTRACT

The School District of Escambia County installed a computer-assisted instruction system with 8 terminals in one high school in June of 1986. Because of the success of the initial pilot project the district now has 240 terminals serving over 4,000 students and adults. The success is in part based on the "power behind the screen" of the Computer Curriculum Corporation system. This article will focus on the five aspects of the computer system that enhances the entire instructional program of the district.

OVERVIEW OF THE SYSTEM

One of the major strengths of the program is the wide variety of curriculum choices and various approaches that can be used with the system. The system operates off of a MICROHOST (mini-computer) which can deliver any of the courses to as many as 128 terminals locally or at remote sites. The courses are in basic math, reading and language skills as well as in English as a Second Langauge for elementary through adult students. Courses are also provided in computer science, logic, and writing which emphasizes thinking and problem solving skills. The entire core system includes over 3,500 hours of daily instructional sessions providing curriculum for students from pre-K through adult in skill building activities as well as in tutorial instruction and practice in subjects the students study independently. Specifically, the four approaches are built into the delivery of presentations to the students, and depending upon student's ability and interest these four approaches can be chosen independently or together. These include (a) drill and practice, (b) problem solving activities, (c) tutorial instruction, (d) homework sheets and assignments. More specifically, the drill and practice provides various activities in math, reading, and language arts which are essential to a student's learning. The problem solving approach gives the students an opportunity to explore solutions using learning resources and tools. For example, a writing course uses an idea processor, "the web", to help students organize ideas for an assignment. The newest math course includes a tool box that students can "open" to use tools such as an on-screen ruler or a calculator. The tutorial program provides the same kind of tutorial help that many of the teachers give to individual students. For example, the math concepts and skills course provides interactive tutorials at the moment a student makes an error and after a student demonstrates difficulty with several exercises in a skill area. These tutorials restate the problem, address a specific error, or guide the student through problem solving steps. Some courses emphasizing tutorials can supplement the present curriculum in areas where there are no instructors, such as in computer science or logic. This is especially effective for school districts where there are limited number of students enrolled in advanced courses. The final presentation provided by the system is the ability to generate customized homework or worksheets for individual students for many of the courses. All of these courses are highly successful because of the management system that is provided in this system.

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MANAGEMENT SYSTEM

The "power behind the screen" is most evident in the automatic management system which continually individualizes instruction for each student based upon that student's performance. A variety of progress and diagnostic reports help the school and the teacher track gains and plan instruction. Specifically, the management of the system involves five major organizational activities. These include: The strands structure within many of the courses which presents practice and instruction individualized in specific skill areas for each of the courses. For example, the math skills course is organized into twelve strands; addition, subtraction, multiplication, division, number concepts, equations, U.S. measurement, metric measurement, fractions, decimals, applications, and problem solving. The "power within the system" keeps the student functioning for a minimum of 60% of his time in those strands in which he is having the most difficulty and 40% in those that he is doing at or above his average level. This individualized decision making within the computer allows for students to continue to make gains as needed.

This gain is basically controlled through the motion algorithms within the system which continues to adjust the level of instuction and emphasis based upon each response made by each individual student. The standard motion algorithms that are part of the management system determine the number of exercises a student receives in each exercise group of a strand before advancing to the next exercise group. Each group has a predetermined minimum and maximum number of exercises for the system to present, based on the range of exercises available in that group and the importance of the skill objective at that particular level. After the student completes each exercise, the management system updates its records of the student's performance in that exercise. When the student has taken the minimum number of exercises, the management system will evaluate the pattern of student correct and incorrect responses after each exercise to determine if mastery of that exercise group has occurred. Mastery of an exercise class is typically based on a sequence of correct responses. A sequence of consecutive correctly answered exercises is reliable evidence that mastery has occurred, and the student is moved to the next exercise class. If the student reaches the maximum number of exercises specified for the group without demonstrating mastery he/she will advance to the next exercise group but the unmastered exercise class will be marked for review. Review is a method of delaying the reintroduction of a skill objective that the student has found difficult and takes advantage of the possibility that given time the student may learn from experiences with or outside the course and be able to master the skill (ref 1).

The processing that occurs behind the screen is recorded in a variety of reports that are easily made available to the teacher. At any time the system can produce printed reports that show the status and progress of each group of students. There are presently three reports available through the system. These are: A current status in the course report; a grouping report which groups students by skill areas in which performance is lowest; the third report details students progress over time. In addition to the three reports within the system, the school or district can create customized reports, e.g., a report to correlate skill coverage with the district objectives. The fourth major "power behind the screen" is the initial placement motion within the management system which adjusts the courseware or lessons to each student's appropriate performance level. Initial placement motion (IPM) is an adaptive process that successfully revises the student's grade level in each strand as set by the standard course motion, with the objective of reliably estimating the student's functional level in the course. This initial placement allows the automatic management system to focus in immediately on the areas of strength and weakness in this specific strands allowing the students to move forward from that area with subsequent adjustments made throughout the process. The final strength of the system is the teacher/student choice within the system. The system allows the teacher to enroll the student in the course(s) he/she needs or within a specific strand based upon teacher observation.

INDIVIDUALIZED PRESCRIPTIVE STRATEGY

This new program can pinpoint when a student or group of students will reach a performance goal. As used by the school district according to Evans, 1988 (ref 2), the purpose of the IPS program is to allow for the setting of a gain/in-grade level placement goal for each individual student; then from regularly updated data, predict how long it will take that student to reach the goal; in addition, when a student's gain falls below the predictive learning curve, recommended specific intervention strategies can be employed to almost guarantee that student in meeting the present goal. The IPS program introduces a new quantitative concept of curriculum management which will enable teachers to follow in detail a student's progress, and to intervene where necessary at an early date if progress is not satisfactory. The IPS program utilizes data from the student histories in the CAI program. This information is collected weekly and stored in a special operating system files within the computer. This stored information is used to produce monthly reports that summarize the student progress for that period and provide the basis for intervention if needed. At the end of the year the CAI data together with student achievement, pretest and posttest scores are used to prepare an evaluation of the effectiveness of that CAI program.

RESULTS AND APPLICATIONS

The district has been able to use the computer with many types of students within the district. Primary use has been for the students "at risk." However, other students such as special education students, gifted students, regular education students and adults have been involved with the system and significant gains continue to be noted by each student. During the 1987-88 school year, the issue of basic skills for high risk students was addressed. During this period of time 2,004 basic high risk students participated for a total number of

75,793 sessions. Of the highest risk students, 300 of the greatest risk of dropping out of school, those disadvantaged JTPA (Job Training Partnership Act) students, only 4 students dropped out. Specifically, the two basic skills worked on with those students indicated that for an average of only 9 hours and 54 minutes students made an average gain of .71 in reading, and for 11 hours and 22 minutes made a .98 gain in math, which is half the recommended time needed for maximum gains. Similar results are being obtained by other populations of students with a significant impact being noted with the illiterate adult issue. The retention rate for adults has been significantly higher, and the number of adults in the program has doubled in the last year, with increased attendance and increased number of students completing the program. The system provides adult literacy courses from 0 grade level to all four levels of the GED.

THE FUTURE

Based upon continued satisfactory and positive gains, the district will continue to carefully monitor the results of the program. However, in looking at the future of technology, especially of the CCC System, this can best be summarized through a speech delivered by Dr. Patrick Suppes at the International Conference on Intelligent Tutoring Systems, University of Montreal, on June 1, 1988. Dr. Suppes, Chief Executive Officer, Computer Curriculum Corporation, indicates that he sees the future of intelligent tutoring systems such as his to include the ability to predict the student's progress. Although the system has the IPS program, the sophistication for each individual student is needed; and as Dr. Suppes states, "What we need in the future, as the theory is developed and tested more thoroughly are explicit, dynamic algorithms for adjusting the time spent by the student and in some cases the kind of tutoring to his specific progress." Presently, the Corporation is having reasonably good results in predicting for three to six months in advance the progress of individual students as described under the IPS section. However, a more powerful theory and prediction is necessary if technology is to provide a good intelligent global forecast of a student's progress. Secondly, Dr. Suppes indicates that a system should have the ability to do a cognitive diagnosis of learning difficulties and that a computer system should be able to provide an exact source of errors separating casual mistakes vs. those that result from not understanding the exercises. Finally, he indicates that maintaining the motivation of the students while on the computer is certainly something that needs to come with the future. The ability for the computer to recognize when a student is letting his mind wander such as observing his eye movements and focusing his attentions. These three areas, which he and Computer Curriculum Corporation are exceedingly interested in and are continuing to provide research, should be resolved in the future.

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A MODEL FOR EMPOWERING AT-RISK STUDENTS THROUGH TECHNOLOGY

Diane Gess. Ed.D.* and Pam Hale°

ABSTRACT

This report describes the implementation of an unusual technology-based staff development program entitled "Turnkey Training With a Twist." This program has made a difference in both the writing abilities and the self concept of all of our students, but especially those who have been identified as "at-risk." The program was initiated in response to a need fostered by the proliferation of large numbers of at-risk students in our district. Many of these students are identified as PSEN and ESL, but many others are underachieving youngsters who carry their emotional problems to school with them. These children most often have great difficulties with reading and writing. However, what all of them appear to have in common is their willingness to write on a computer. The district had previously implemented a comprehensive writing curriculum, Project WRITE, using "Write Track" materials, which stress student editing through addition, deletion, rearranging and writing for an audience. This successful program, easily adapted to word processing in the computer lab, still did not allow for ease of publishing the students' work. Seizing on an opportunity to use technology as a motivational as well as an instructional tool, we successfully applied for legislative funds over a two year period. As a result of these two grants, Macintosh publishing centers were placed in each of our elementary and junior high schools along with a local Bulletin Board System linking students and teachers in these schools. Through evaluating and refining the delivery of this "Communications Network" project over two years, the coordinators have been successful in developing a model whereby we can identify highly motivated staff through the use of a RFP (request for proposal) in which teachers could apply for the use of a publishing center in their own classrooms for one year. The turnkey quality of this project and the built-in equipment incentive for staff, has allowed technology to spread to a number of classrooms in a cost-effective manner. Teachers successfully training teachers on their own time is the concept underlying "turnkey training with a twist." This motivationally-charged project has yielded many exciting results. However, the most rewarding return has been the empowering of our high risk students with increased self-esteem gained primarily through the "publishing" of their writing products.

BACKGROUND

The East Ramapo School District, located thirty-five miles northwest of New York City in Rockland County, has a large number of students who have been identified as at-risk students. One of the technology goals for the district has been to seek out appropriate uses of the computer with this target population and to study those strategies

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which appear to have the most benefit. Assigning computers received through a legislative grant to specific classrooms appeared to be one viable way of meeting the stated goals. Prior to the implementation of the technology model described in this paper, teacher recipients of these computers for classroom use were identified and selected by building principals. Not all of these appointed staff members became enthusiastic users and on occasion equipment gathered dust in a corner until a more interested colleague "borrowed" the equipment for his or her own use. Our concern was to find an acceptable way of relocating these under-utilized computers and future equipment acquisitions into the hands of teachers who evidenced an interest in learning more about classroom technology, and to help motivate and educate our substantial numbers of at-risk students.

For the past five years, it has become evident to the technology staff that small segments of the teaching staff were emerging as leaders in the innovative use of the new technologies. The question was: "How do we, with constraints of union policies and budget limitations, tap the resources of these technology 'self starters?" The answer emerged with the creation of a model which identified these teachers and provided them with appropriate resources for further exploration of the technology. It also allowed for a sharing of their expertise with colleagues. This unusual technology-based staff development model ultimately empowered staff to become the source of new ideas and subsequently empowered at-risk students with stronger self-esteem.

PROJECT DESCRIPTION

Phase One - Creating an RFP (Request for Proposal)

An RFP was distributed to all elementary teachers for the purpose of allowing them to apply for the use of a desktop publishing station in their classroom for a period of one year. The station consisted of a MAC computer, Imagewriter printer, modem, and graphics, word processing, and telecommunications software. Since the district already has its telecommunications program in place through our "Communications Network Program," the grant winners would become a part of this network. Applicants for this desktop publishing grant were asked to meet the following criteria: 1. Submit a detailed description of how they would use this equipment should they receive the award. 2. Designate and acquire the signature of two colleagues who agree to be trained by the grant winner on both the turnkey trainer's and trainee's own time. 3. Become part of the "Communication Network Program" by submitting a log of activities and published samples of work.

Phase Two - Selection of Grant Winners

The enthusiastic response to the RFP left the "Communication Network" coordinators, Gess and Hale, with the pleasant task of evaluating the creative proposals and making decisions about the distribution of the equipment. The coordinators were concerned with maximizing the impact of equipment in a variety of settings where at-risk students would benefit.

Phase Three - Training

Training sessions were held after school hours without monetary compensation to any of the participants. To receive the equipment, the grant winners were required to attend a six-hour preliminary training session during which time they were introduced to the hardware and graphics and publishing software and witnessed an on-line telecommunications demonstration. Following the training, participants were asked to do follow-up activities on their own. Each was requested to: 1. learn the word processing software, 2. submit diary entries in a log describing use of the equipment and training efforts with colleagues, 3. submit final published student work on a regular basis.

Phase Four - Telecommunications

An integral part of the East Ramapo "Communications Network Program" is a district electronic bulletin board. Housed at the Spring Valley Senior High School, this bulletin board will be accessible by every school through modem and telephone lines and all but a few elementary schools are presently on-line. It is expected that all of the elementary schools will be on-line within the next year or two. The initial activity for this phase of the program is an on-line in-service course. Teachers have the opportunity to use computers and modems to transmit information electronically and to respond to the course instructor through the use of the bulletin board.

Phase Five - The Technology-Writing Skill Connection

Once the equipment and software were in place, student motivation to accelerate the production of "publishable work" became evident. The procedure for moving from idea to published copy is linked to the district's successful writing program, "Project WRITE." Based on a series of organizational strategies called "starters," and other fluency-based strategies called "improvers," this developmental writing program has been used in the district since 1981. Because Project WRITE follows a developmental and systematic approach, many at-risk learners have been taught to produce successful writing products in a variety of genre. Even the most reluctant writer is practicing keyboarding, editing skills, and functional grammar through creative expression. The word processor has allowed Project WRITE strategies to be transferred to practical application of revising, editing, and revising again, without the frustration that pen and pencil has caused for these students. Skills such as sentence composing, sentence expansion, substitution of overused words, moving and rearranging, combining and embedding, paragraphing, and planning for full-lenth compositions have become easier through the use of the computer. Teachers using the Communications Network" desktop publishing equipment are able to transfer all of the student's writing into the Macintosh environment. Clip Art and other graphics created by MACPAINT, allowed the students' writing products to take on a polished and professional look.

RESULTS AND EVALUATION

Over the past two years, we have seen that desktop publishing does empower at-risk students. Concrete evidence increased self-esteem in these at-risk children is clearly observable. This is particularly noticeable in the change of attitudes towards writing and the willingness of students to go through the long revision process to attain a "publishable" writing product. These students help one another, have a new sense of community, sense of achievement, and see themselves as "smart" and special, especially when their work is in print and often placed in a library or other classrooms for a wide audience to read. Original feelings of failure in the reading/writing areas have been replaced by acquisition of confidence through new reading-related skills gained through the Project WRITE.

Through tracking the number of writing products produced by all students and noting the increase of writing activity among students who have been identified as "at-risk," the staff has concluded: 1. it is key to engage students in writing activities which encourages publication, 2. by learning to identify and write for a specific audience, there is built-in motivation to use revision strategies since students want to "get it right," 3. it is likely that students who write for publication will also read the work of both professional and student authors and these publications can serve as a model for their writing, 4. cooperative learning, a key to educating in a heterogeneously-grouped classroom, becomes the vehicle by which students share functions of writing. Through this project importance has been given to the talents and skills of many at-risk students who heretofore have not met their potential.

"Why desktop publishing for at-risk students?" The coordinators of this program concluded, based upon observable data, that there has been evidence of growth in self-concept and an increase in the quantity and quality of writing products by at-risk students.

CASAS - COMPUTER AIDED STUDENT ADVISING SYSTEM

J.R. Rinewalt, C.T. Nute, J.R. Comer, D.J. Rodjak*

ABSTRACT

Academic advising of students is a time-consuming task. Effective advising requires extensive preparations to become and remain familiar with degree requirements and optimum course sequences for students in different stages of the curriculum. An excessive amount of time is often spent with a student checking their academic record and comparing it with requirements rather than answering a student's advising questions. Such checking frequently involves more than merely looking for successful completion of a set of courses; for example, checking GPAs, residency requirements, etc.

Many of the mechanical functions can be automated. This paper describes a generic university level Computer Aided Student Advising System (CASAS) which runs on an Apple Macintosh™ computer. CASAS emphasizes ease of learning and use; it is being developed by a team of graduate and undergraduate students at Texas Christian University.

INTRODUCTION

One time-consuming task that many faculty are involved in is the advising of students. While advising is critical to a student's success and can be rewarding, much of the advising process requires the tedious and error prone checking of student progress against requirements listed in catalogs, bulletins, and student files. To be effective, an advisor must keep abreast of the varied requirements of different degrees (e.g., BA vs. BS), the changes that occur when new catalogs are published, and the special requirements that arise when advising transfer students or students with unique needs and backgrounds.

Many of the mechanical and less appealing aspects of advising lend themselves to automation. The benefits of such automation include freeing up time of both the faculty advisor and the student, reducing the risk of oversight or error, and introduces a greater consistency in the advising process; a process which is frequently viewed as a task that is to be endured, but should be completed in the most expeditious fashion possible.

A few years ago one of the authors was involved in a project to automate the advising process in the School of Engineering at the University of Texas at Arlington (ref 1). While the resulting advising system has proven to be very effective for many of the engineering departments, the system has not gained wide acceptance in other parts of the university. The major deterrent has been the reluctance of other faculty to learn to use the rather terse and cryptic user interface and the effort required to maintain the database of requirements. Furthermore, the system was designed around the specific degree requirements of the University of Texas and would not readily lend itself to use in other colleges and universities.

During the past year, the authors have begun work on a more general Computer Aided Student Advising System (CASAS) which is aimed at overcoming some of the limitations of the earlier system while offering even greater capabilities. The specifics of CASAS are described in a requirements document that was written this past fall (ref 2). CASAS is hosted on an Apple Macintosh™ and makes extensive use of the standard Macintosh user interface (ref 3). The remainder of this paper describes the CASAS capabilities and interface.

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CASAS CAPABILITIES

CASAS is generic in its design and is intended to be applicable to a wide set of colleges and universities. It is not restricted to a specific type of college (i.e., CASAS should be as useful in a school of engineering as it would be in a school of dance), nor is it restricted to a specific degree (i.e., CASAS should be equally useful in a small, two year community college offering an Associate of Arts degree as it would be in advising graduate students at a large university). The requirements of a number of different institutions were considered when developing the specifications and design of CASAS.

CASAS is based on a hierarchical set of requirements. At the highest level are the university wide requirements. Beneath the university requirements are college requirements, then departmental requirements, and then individual student requirements at the lowest level.[1] This hierarchy defines a tree structure rooted at the university level with subtrees for each of the colleges, sub-subtrees for each of the departments, etc. Note that requirements are cumulative from the top down. Thus, a university requirement is applicable to all college levels and below, but requirements at a lower level in the tree do not necessarily apply to higher levels or in other branches of the tree.

Typical university level requirements are minimum number of credit hours, minimum overall GPA, specific course requirements (e.g., freshman English), residency requirements, and time limits to complete a degree. College level requirements might include admission to a particular program (e.g., pre-med program), more stringent GPA requirements, specific course requirements (e.g., all students in engineering have to take three semesters of calculus), and a minimum number of upper division level courses. Departmental requirements could include work experience (e.g., student teaching or nursing, co-op work, etc.), minimum GPA for certain courses (e.g., courses taken in the major, courses taken in a specific department, upper division courses, etc.), demonstration of talent (e.g., submit a paper for publication, exhibit art work, or participate in a musical performance), and additional specified courses. Requirements for an individual student typically include deficiency courses that must be completed and the selection of specific courses from among a set of possible alternative courses.

CASAS is capable of representing all of the above requirements as well as many others. Furthermore, it offers its users a number of options for describing these requirements. As an example, an institution may elect to augment the usual letter grades A, B, C, D, and F with pluses and minuses, grades for Pass/Fail or audit, various withdrawal grades (e.g., withdraw passing, withdraw failing, withdraw at the request of the dean or instructor), etc. Numeric values can be associated with the various grades including the standard 3 point and 4 point systems, and fractional values for "+" and "-" grades. Users are further given the option of including or excluding certain grades when computing GPAs. For example, transfer courses may or may not be included; when a course is taken a second time then both grades, the latter grade, or the higher grade can be used in computing GPAs.

CASAS depends on a set of databases for representing the various requirements and maintaining information about individual students. The requirements portion of the database is subdivided into a portion that describes the course offerings of the various departments and a configuration portion that reflects the hierarchical nature of the system (i.e., university level requirements, college level requirements, etc.). The courses data includes a course description, a course name and number, the number of credit hours, a list of prerequisites or corequisities, a set of equivalent (i.e., possible substitution) courses, and any special user defined requirements (e.g., a course requires permission of the instructor, is restricted to majors, can not be taken for credit by certain students, etc.). The configuration requirements are based on the institution's catalog and there is a separate set of configuration requirements for each published catalog. (The different configuration requirements reflect the differences in the requirements of the various catalogs.)

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[1] It is not necessary to include all levels of the hierarchy. Thus, a small college that consists of a set of departments would not necessarily make use of the university level requirements.

The student database includes the information necessary to identify the student, including name, ID number, and address; a history of the student's completed coursework, including grades and transfer credit; and a "degree plan". The degree plan indicates a student's major, the degree the student is pursuing, date of admission, applicable catalog, special honors, probations or other restrictions, and proposed courses. The advisor has the option of waiving or substituting for any requirements on a degree plan. The degree plan serves as the basis for all student advising.[2]

CASAS USER INTERFACE AND USE

A major consideration in the design of CASAS has been the desire to keep it easy to use. In particular, we wanted to avoid requiring that a user would have to learn a syntax for typing in commands which typically involve learning a number of commands and their rigid (i.e., unforgiving) command structure. The Macintosh interface, which is based on the use of pull-down menus, has proven to be easy to learn and use (ref 3).

The Macintosh interface uses a set of menu items which are listed across the top of the computer's screen. Each menu item is labeled with a suggestive title (e.g., File, Edit, Advisement, etc.). An advisor uses a mouse to point (i.e., select) one of several menu items. When selected, a menu item expands downward into a list of options, each with their own suggestive title. An advisor then selects a particular option which either takes some action immediately or presents a stylized dialog box which offers the advisor a set of options (e.g., a list of possible courses) or requires a value to be entered (e.g., a student's name). These ideas are illustrated in figure 1 which shows the "Show Student Report" option of the selected "Advisement" menu item.

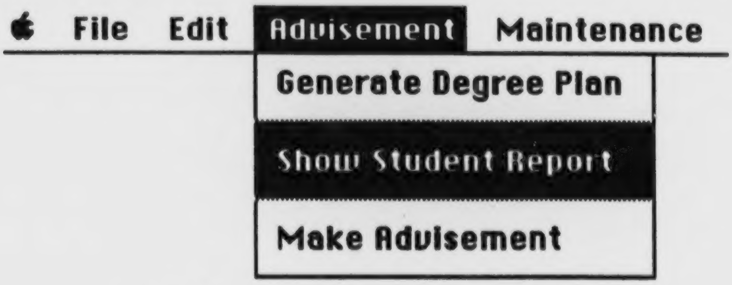

Figure 1. Macintosh Menu and Options.

Because the menu items are always displayed, an advisor is not forced to memorize a list of commands. The names of menus and options make their meaning and use fairly obvious and greatly reduce the risk of an advisor attempting to take an inappropriate action. Options that are not applicable under a given menu are shown in a lighter grey type so the advisor is made aware that the option is not available at that time. The risk of error is further reduced since there is relatively little typing on the part of the advisor. Finally, the effect of an erroneously selected option or value can usually be immediately corrected by a special UNDO option under the EDIT menu.

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[2] A student is not required to have a formal degree plan on file before he or she can be advised using CASAS. A default degree plan is used until a student declares a particular major and choice of degree.

At the conclusion of an advising session a student can be provided with a printed copy of their degree plan, updated to reflect the results of the advising. CASAS allows advisors to generate templates for these advising reports and then use a specified template for any number of students. These advising reports can be tailored by the advisor to include as little or as much of a student's information as desired.

CASAS also allows a user to define more general report templates which list a set of students or provides a summary for a set of students. The set of students that are to be included in such a general report is specified in terms of a predicate expression. The expression can be based on a combination of factors such as range of GPAs, range of hours completed, specified majors, degree being sought, etc. These general reports are useful tools for identifying students having difficulty, students eligible for various honors or membership in scholastic societies, students who will soon be eligible for graduation, etc.

In addition to the benefits of reduced time required to advise a student and the lessened risk of errors, CASAS allows the advisor and student to investigate various "what if" scenerios. Often a student has the option of graduating under any of several catalogs, each with different requirements. By changing the catalog entry in a student's degree plan, CASAS will update the student's degree requirements. The revised requirements are then automatically compared against the student's previously completed work to determine the remaining requirements under the alternative catalog. Similar comparisons can be done for alternative choices of major and alternative choices of degrees.

CURRENT STATE OF THE CASAS DEVELOPMENT EFFORT

Work began on implementing CASAS during the fall semester of 1988. Most of the work was performed by nine graduate students who were enrolled in the first semester of a two semester project course. The class was divided into three teams of three students each. Each team was responsible for developing a prototype of the user interface for the system. At the conclusion of the semester a composite design was selected based on the best attributes of each of the three team's work. This spring the same students will be augmented with seven senior undergraduate students and a single, complete CASAS system will be implemented.

Based on the result of the fall semester, the authors feel that it is not unreasonable to have a preliminary version of CASAS by the end of the spring semester. We hope to make use of the system for this summer's and the coming fall's advising sessions at TCU. We anticipate that a number of bugs and areas for improvement will be identified by these first uses of the preliminary system. It is our intention to revise CASAS in the coming semester or two so that we may have a truly useful advising tool in the near future.

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THE HIGH TEaCH FAIR: A DISTRICT-WIDE MINI-CONFERENCE

T. R. Black*

ABSTRACT

An annual HIGH TEaCH FAIR gives teachers in Portland Public School District #1 an opportunity to see how their colleagues are using computers in their classrooms. This "mini-conference" is held during Computer Learning Month at a local high school. A keynote speaker and concurrent sessions provide a varied selection of presentations for computer users of all experience levels. Highlights of the method used for the successful implementation of this project are described in the following précis. Specific information and forms will be made available during the presentation.

INTRODUCTION

The HIGH TEaCH FAIR, a district-wide mini-conference, provides teachers in Portland School District #1 with the opportunity to share successful techniques for using computers in the classroom. The first mini-conference, held during the 1985-1986 school year, was called "NonTech Learning Fair" and was targeted for teachers who were not computer users. The major goal of the first mini-conference was to provide an opportunity for non-users to realize the instructional potential of the available technology.

BUDGET PROPOSAL

The HIGH TEaCH FAIR continues the mini-conference format and enjoys a teacher audience that ranges from non-user to "computer coordinator". Attendance at the HIGH TEaCH FAIR has tripled during the last three years as a result of careful planning. Although much smaller than a "conference", the HIGH TEaCH FAIR is similar in the scope of organizational details required to make it a success. Perhaps the major difference between a conference and a mini-conference is size of the budget.

The first step in planning is to prepare a proposal including all budget items. Budget items for the HIGH TEaCH FAIR include expenses such as: honorarium and expenses for keynote speakers, payment of release time for teachers to attend planning meetings, refreshments, printing costs and door prizes. Local speakers will sometimes waive the honorarium. Portland area vendors have donated door prizes from their shelves as well as gift certificates from exclusive department

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stores. Another popular low-budget door prize has been a teaching assistant gift certificate from a district administrator. The recipient may use the administrator as a substitute or as an aid while s/he uses the time for planning.

The proposal should include a possible date and location. The first HIGH TEaCH FAIR was held on a sunny Saturday at the end of a grading period in January. The date that has worked best since then is state-wide teacher inservice day which is a Friday during October which also happens to be Computer Learning Month. Once the proposal is accepted by the appropriate administrators and the budget is approved, the real planning begins.

SESSION PRESENTERS

Locating the teachers who are using computers effectively in their classrooms is the next step in planning the HIGH TEaCH FAIR. The most valuable resources that any district has are creative teachers who have access to computers. In a district the size of Portland (2700+ classroom teachers) teachers who are resources in this area are relatively visible. They are the ones who are on district committees, who facilitate workshops, who teach classes for local universities, who attend conferences and user meetings regularly. Most have spent an enormous amount of personal time working with computers. The opportunity for teachers to share successful techniques (computer-related or otherwise) is often missing in the school or district setting. The mini-conference can correct this problem in a positive, enriching way.

SITE SELECTION

Once a tentative commitment has been obtained from possible presenters, a site must be located and reserved. Considerations for the site include a central location which can provide many electrical outlets, tables for additional computers, provision for use of audio-visual equipment, phone lines for modems, etc. A "computer rich" site lessens the amount of equipment that must be transported or borrowed. A multipurpose room that will comfortably seat all attendees, accommodate the keynote address and provide work areas for the sessions is ideal. Maps of the vicinity and of the site should be included in printed materials.

PROGRAM PLANNING

With these steps accomplished, it is time to plan the actual program. A theme should be identified. HIGH TEaCH FAIR themes have included (1) "Put Kids in Charge of Technology", (2) "Are Computers a Passing Fancy?", and (3) "Maximizing Creativity With a Micro". A keynote speaker sets the tone for the day with an opening speech or presentation based on the chosen theme. Local as well as out-of-state keynoters have been used for the HIGH TEaCH FAIR. Using local speakers allows for accessibility before and after the mini-conference and reduces the amount of money necessary for expenses. Accessibility also allows for a planning session which includes the keynote speaker and the session presenters.

PLANNING SESSION

Immediately following these decisions, a planning meeting of all presenters is necessary in order to take care of many details quickly and efficiently. Equipment needs, presenters' special requests, materials for reproduction and room assignments are discussed during the planning meeting. If a planning session is not possible, the information must be gathered by phone or by mail.

ADVERTISING METHODS

Advertising for the initial mini-conference is critical to success. The most successful form of advertisement has been to distribute conference programs to Portland's 116 regular, alternative and special schools. This is accomplished at least one month prior to the HIGH TEaCH FAIR. It is imperative that the programs include descriptions of all the sessions and that they be distributed in a manner that will ensure maximum publicity. A "computer contact" person at each of Portland's schools receives fliers, programs and registration forms which s/he is asked to post and circulate in each building or site. Phone calls and site visits by district-level specialists and a letter of support from central administrators encourage principals to promote attendance at the HIGH TEaCH FAIR. A videotape of previous fairs is available for showing at staff meetings. One method of advertising that was suggested on an evaluation form is "skywriting during recess"! This method has not been attempted to date, but might run a close second to inviting the media to the event.

EQUIPMENT NEEDS

With the equipment needs identified, it is time to determine what additional equipment must be delivered to the site. In Portland additional equipment comes from schools, local vendors, and central equipment supply. If a "computer rich" site is used, then little additional computer equipment is needed, but other items are. Extension cords, multi-plugs, splitter cables, and LCD panel display projectors are items frequently requested. Equipment at the site may need to be re-arranged the evening before the mini-conference. Equipment movement can be kept to a minimum by placing presenters with like equipment needs in the same room for different sessions.

ADDITIONAL VOLUNTEERS

Additional people are needed to help on the day of the big event. Registrars distribute materials and name tags to people as they arrive.

Another volunteer must be responsible for the safe delivery of the refreshments. A volunteer "equipment doctor" carries a bag of spare parts and circulates among the rooms ready to help solve equipment problems. At the close of the day, a volunteer can give door prize coupons to those who complete and return evaluation forms. After the door prize drawing, teachers leave with their arms full of materials and their minds full of new ideas. The volunteers also clean up and put the meeting site back in order.

CREDIT

Immediately following the HIGH TEaCH FAIR, participants are mailed a "certificate of participation" which lists staff development hours acceptable for requirements of the State of Oregon Teachers Standards and Practices.

CONCLUSION

Although Portland provides this event for district teachers, the model could be used by any district to present a mini-conference. Perhaps a "micro-mini-conference" could be held at the building level. The HIGH TEaCH FAIR, a form of inservice that teachers enjoy attending year after year, provides a profitable opportunity for teachers to share successful teaching techniques with their colleagues in a professional manner.

Samples of planning sheets, announcements, programs, evaluation forms and certificates of attendance will be available during Terri's presentation.

COMPUTER PERSONALIZED ADULT LITERACY INSTRUCTION

Joanne Olson,[*] **Ray Shepherd**[°]

ABSTRACT

Building on research in computer-assisted instructional techniques and their applications to teaching adolescent and adult learners, interactive videodisc technology and the micro computer were utilized to deliver personalized instructional programs to learners at all levels, basic literacy through GED preparation training, in the following content areas: writing skills, social studies, science, language arts, and mathematics. Comparisons of program results utilizing several different delivery systems over a two-year period are presented for the Employability Through Literacy Program for High School Dropouts and the Continuing Education Learning Center for Adult Literacy.

INTRODUCTION

The proliferation of technical knowledge is creating changes in the workforce at an unprecedented pace. Literate workers are vital to business and industry, which depend more and more on modern technology. With approximately 400,000 adults in the state of Mississippi classified as illiterate, Dr. Kenneth W. Gordon, Dean of Continuing Education at Jackson State University, recognized the need for practical solutions to the problems caused by illiterate employees. Traditional methods of instruction, popular during the pre-technology era, are inadequate. Results of research in 1983 by the Remediation and Training Institute, Washington, D.C., served as a basis for the instructional guidelines in the study: self-paced learning; flexible scheduling; instructional learning style options; frequent feedback on progress; re-cycling; learner accountability; one-on-one assistance as required; positive reinforcement; structured learning environment; and the relation of learning activities to employment requirements.

Computer-assisted instruction was used to implement the foregoing guidelines to accommodate learners with various instructional needs and learning styles. Personalized computer-assisted instruction was designed for all learners in the study.

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STUDY AND METHODS: YOUTH HIGH SCHOOL DROPOUTS

The Employability Through Literacy Program was designed to improve the academic and pre-employment skills of JTPA-eligible young adults, 16-21 years of age, who dropped out of school prior to obtaining their high school diplomas.

The curriculum includes instruction in the following academic areas: writing, social studies, science, reading, and math, as well as the following pre-employment areas: career awareness, job availability, application completion, resume writing, interviewing, punctuality, attendance, attitudes, appearance, interpersonal relations, and on-task behaviors.

The Employability Through Literacy Program is funded through the Job Training Partnership Act (JTPA) and adheres to all JTPA guidelines concerning participant eligibility, recruitment, record-keeping, and reporting. A total of 256 participants enrolled in the program between August 1986 and May 1988. All participants were classified as economically disadvantaged. Sixty percent of the participants were male; forty percent were female. Ten percent of the participants were white; ninety percent were black. All age levels, 16-21, were equally represented.

The participants were enrolled in eleven-week training cycles and received instruction five days per week from 8:00 a.m. to 12 noon. Participants entering the 165 hours of academic training were pretested for entry reading level on the Slosson Oral Reading Test (SORT), published by Slosson Educational Publications. Subsequent testing utilized the reading comprehension and mathematics concepts and problems subtests of McGraw-Hill's Test of Adult Basic Education (TABE), 1976 Edition, Level E, M, or D, and the Official GED Practice Test Form A, distributed by Cambridge Educational Publishers. Based on the results of these tests, participants were placed in academic programs designed to maximize the possibility of passing one or more GED subtests.

Instructional methodology included one hour daily of computer-assisted instruction. Tandy 1000SX computers were used with software selected on the basis of relevancy to GED Test skills and appeal to young adults. Software selected included: the Reading Series, Writing Series and Math Series, published by Queue; Alcohol: Four Interactive Programs by S.A.S. Software; and Writing: S.A.S. Hartley Series. One training cycle utilized the WICAT System 1250C with courseware tailored to meet the instructional requirements of the GED Test objectives. Participants were posttested during the cycle on the reading comprehension and math concepts and problems subtests of the TABE, Form B of the Official GED Practice Tests, and with the GED Test.

Sixty hours of the total 225 hours were devoted to pre-employment skills. Participants were pre-assessed by written test and interview. Instruction was given to participants in deficient areas by computer-assisted instruction, teachers, and guest speakers. Participants completed resumes on the computers, completed the Pre-Employment Training software by Educational Associates Inc., and were videotaped and critiqued doing practice interviews. Participants were posttested with written exercises and performance activities.

RESULTS

Entry reading comprehension scores (TABE) ranged from grade score 2.9 through 12.9. The average reading comprehension pretest score (TABE) for participants for whom both pretest and posttest scores were available was grade score 7.5. One-third of the participants scored below seventh grade level. Posttest scores show a grade score gain of .7 (to grade score 8.2). For math concepts and problems, the average pretest score (TABE) was 6.6. Posttest scores show a grade score gain of 1.2 (to grade score 7.8) One-third of all enrollees (eighty-six participants) received the GED certificate. An additional thirty-six percent (ninety-four participants) completed between one and four of the five subtests of the GED Test. Twenty percent of the participants who completed the GED Test enrolled in college. Nineteen percent of the participants obtained employment while enrolled in the program. Thus, program participants experienced ninety-seven percent positive completions by successful completion of the pre-employment training component, the GED Test or one or more subtests thereof, or entry into the workforce.

STUDY AND METHODS: ADULT WORKFORCE

The Continuing Education Learning Center is a learning laboratory designed to teach basic reading, writing, and computational skills, critical thinking skills, and General Educational Development (GED) preparation to employees or potential employees over 21 years of age. The laboratory contains four interactive videodisc units and eight personal computers, as well as a video cassette player/recorder and four cassette tape player/recorders.

A total of 213 learners enrolled at the Center between October 1987 and October 1988. The Slosson Oral Reading Test was used to determine the reading level of each learner. The learners, enrolled in 100-hour time blocks, were scheduled a minimum of one hour per day, five days per week, or two hours per day, three days per week. Each entered a program consistent with his or her reading level. Eighty-five of the learners were reading below the fourth grade level and were placed in the basic reading/writing program, employing the Principle of the Alphabet Literacy System (PALS), a computer-videodisc interactive program. The thirty-nine learners reading at grade levels between five and seven were placed in the intermediate program (PreGED), and the eighty-nine learners reading at the seventh grade or higher level entered GED Preparation. (Ref. Table 1.)

Multimedia resources and text materials were used with computers in the latter two program components. In addition to the Slosson Oral Reading Test, learners placed in the GED component were also given standardized GED Practice Tests and skills tests to diagnose learner strengths and weaknesses. Coursework was prescribed and assigned based on the diagnosis. The GED program followed the five subsections in the GED Test: Reading, Writing, Social Studies, Mathematics, and Science. Both the intermediate program and the GED program include prescriptions for vocabulary improvement and thinking skills.

RESULTS

In the first year (October 1987 to October 1988) of operation of the Continuing Education Learning Center, 213 adults were enrolled. Of this number, forty percent enrolled in the basic program, and sixty percent enrolled in the PreGED or GED program. One hundred thirty-four, or 62%, completed the assigned programs and exited; thirty-five, or 16%, dropped out of the program; and thirty-seven, or 16%, reenrolled in additional 100-hour blocks. The average gain in reading for those enrolled in basic and PreGED programs was 1.8 grade levels. Of the learners enrolled in the GED program, twenty, or 22%, earned the GED, and fifty-five, or 62%, completed one to four parts of the test. Learners taking the GED Test scored above average in each subsection (Table 2).

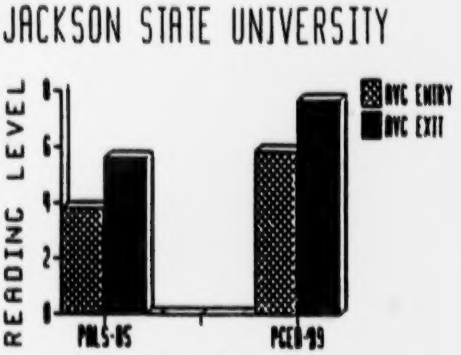

Table 1

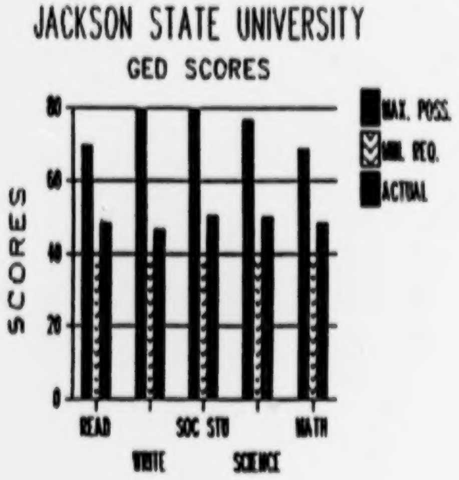

Table 2

][NET - ITS EDUCATIONAL IMPLICATION IN COMPUTER STUDIES AND INFORMATION TECHNOLOGY COURSES.

IP Wing Chung *

Abstract

][net (pronounced two-net) is an inexpensive local area network developed by a school teacher for his own classroom use. However, some features of this LAN turn out to have significant implications for Computer education and Information Technology courses. The simple][net design is within the understanding abilities of the secondary school students taking Computer Studies and this concrete example enables the students to fully appreciate the functional parts of LAN. The integration of the network commands into a high level programming language, namely BASIC, opens a new and exciting programming area for the students.

In the paper, the author describes how two of his students wrote a pair of programs in BASIC to simulate the operations of a BANK and the automatic teller machines. At least three and up to eight microcomputers can be connected together by the][net referred earlier in this paper. One of the microcomputer simulates the BANK and keeps records of all customers. All other microcomputers are simulating the automatic teller machines. Customers can approach any one of these machines to get access to his own account and perform the required transaction.

Although these are simulation programs, the experience in writing such communication intensive programs have important implications for the future development of IT courses.][net transforms theoretical study of network communications into practical experiences.

INTRODUCTION

][net is an inexpensive local area network I designed and implemented in 1987 for the APPLE II microcomputers. To minimize the construction cost, minimal hardware is used. This strategy turns out to be very educational. My students actually help me to construct all the hardware and through this process they acquired a fairly clear concept of the ISO - OSI network model. Some of them generated sufficient interest and began writing application programs for][net. In this paper, I shall begin by describing the][net hardware and software characteristics, then describe how my students started programming and finish by including a preliminary evaluation of the possible application of local area network in IT courses.

CHARACTERISTICS OF][NET

Some background of the Microcomputer

Every APPLE II microcomputer is equipped with a built-in game input-output port. There are four single-bit output ports as well as three single-bit input ports. These ports are memory-mapped to the linear address space of the 6502 micro-processor of the APPLE II microcomputer. The ports are TTL-compat-

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ible and can be connected using simple diodes and transistors. There are also four resistive input ports. By connecting different resistors to these input ports, the built-in hardware can read the resistors in the ports and return the results in the accumulator.

][net is built around this game input/output port for two reasons. Firstly, every APPLE II microcomputer has this game port so that minimal hardware is involved. The game port is fully buffered and has sufficient fan-out capacity to drive up to 12 microcomputers without additional buffering. Since we have 11 APPLE II microcomputers in most secondary schools, the built-in buffer is sufficient for normal use. Secondly, because of a strange condition in the maintenance contract between the APPLE II microcomputers dealers with the schools here in Hong Kong, we are not allowed to add any add-on cards to the machines. However there is no restriction on the use of this game port. In order to share my work with other schools, I must observe this restriction.

Hardware Characteristics

][net can be conceptually divided into two distinct parts - the hardware and the software parts. The hardware part can be further divided into three major components: the system bus, the][net interface and the controlling microprocessor.

The system bus is a three-core wire joining all the APPLE II microcomputers of the local area network. At the physical ends of the bus, three resistors are used to hold the voltage level of the bus as well as eliminating the unnecessary reflections of the signals running on the bus.

Three of the four single-bit output ports of the microcomputers are connected to the bus using OR-logic which is provided by an interface board. The three input-ports are also connected directly to the bus. Beside providing the connection, there is also a variable resistor on the interface board. This a variable resistor is used for setting the station identity of the microcomputers in the network.

There is actually no microprocessor on the interface board. The controlling microprocessor is the main microprocessor of the APPLE II microcomputer. Normally, the main processor will perform its normal duty. During communication, the 6502 processor will translate the data into suitable form for transmission as well as control the signals on the bus.

In short, the hardware is very simple. My students, who came into contact with computers formally for the first time and had no past experience in electronics could begin production of these interface boards after a very short period of instruction. Furthermore, the cost of building such interface board is very low as it includes only a few diodes and some variable resistors. The most costly item in the whole network is the cables and the connectors if the development cost of the software is neglected.

The Software Characteristics

The software of][net can be logically sub-divided into two layers: KERNEL, and the matching NOS and FS.

The inner-most layer is called KERNEL which controls all the communication between the stations. KERNEL also handles transmission errors and network access. With the help of a control block, KERNEL can send or receive a block of data defined in the memory. Hence to send data, it is necessary to put the data into the memory, construct the control block and pass the control to KERNEL. To receive data, it is necessary to prepare a sufficiently large memory as receiving buffer, construct the appropriate control block and pass the control to KERNEL. KERNEL does not query or care about the data. When it is instruct to send data, it just gets the data byte by byte, prepares it and translates the bit pattern of the byte into suitable streams of electrical signals and passes them to the interface block. During reception, the above process is reversed. It reads the signals from the interface, resembles the byte and puts the data into the memory buffer as given in the control block.

To remove users from all the hassles of the control blocks and to ensure that users' commands are understood and carried out by the rest of the network, I implemented two softwares which work in harmony at both ends of the communication. They are called NOS and FS. NOS interfaces the KERNEL with application programs and/or users by providing a set of BASIC compatible commands. FS actually implements these commands at another station which acts as the center of the network. On one hand,][net is a bus-structured network in the sense that the signal from one stations can be read by every other station. On the other hand,][net is a star-structured network because all the users' requests are processed by a dedicated station called File-server. FS is the software that is running in the File-server to provide the file storage, printer spooling and electronic mail facilities of][net.

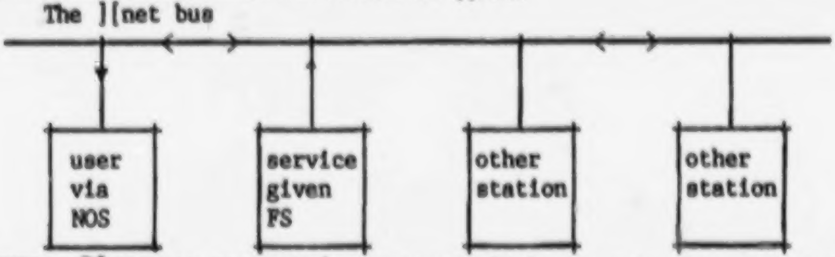

Figure: If a user requested a program which was stored in the FS by giving the command &"LOAD ETC", the program is retrieved from the disk connected to the FS, and then sent to the user via the interface board and the][net bus.

CHARACTERISTICS WHICH PROMOTED NOVICE PROGRAMMING

There are three important factors which make my students capable of writing impressive programs during their first year of formal contact with computers and local area network.

I cannot deny my personal influence on the students. My intense interest of my own brainchild is apparent both within class and outside normal teaching hours. I need some of my students to help in doing the routine construction and asked for volunteers. These volunteers also influenced their peers so that an atmosphere of interest and enthusiasm is created. This atmosphere is very important in maintaining the motivation and enthusiasm of the students as inevitable difficulties are encountered during their learning process and programming activities.

The second factor is the compatible of the commands with the high level language students are learning at the same time. They are taught BASIC and the][net commands can be used in their programs. The initial knowledge barrier needed to start doing useful work is reduced to a minimum. For example, to send an electronic mail to the user at station 2, the][net command is

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&"MAIL 2 this is the message"
```

and the corresponding command to get any message is

```
&"GETMAIL"
```

These commands can be incorporated into the program like this

```
10 A$ = "MAIL 2 "
20 INPUT "YOUR MESSAGE TO STATION 2:";B$
30 A$ = A$ + B$
40 &A$
50 &"GETMAIL"
60 GOTO 10
```

The above program sends out electronic messages to station 2 and gets messages back continuously in an infinite loop. Basing on sample program like this, two of my students devised a set of programs to simulate the operation between the bank and the automatic teller machines. One program simulates a bank and gets messages from other program simulating the teller machines. When a message is received, it is decoded and the request processed. The result is transmitted back to the teller machine program by electronic mail. This set of programs is complicated but can be managed by some better students, however the satisfaction, excitement and thrill the programmers get after successful completion is beyond description.

The third element which is essential is the concept of the layered structure of any communication system. In this era of information age, it is my most sincere belief that a knowledge of the operation of electronic communication is essential to the future office workers. The early exposure to these concepts will facilitate future job adaptation.][net is structured around the International Standard Organization's Open Structure Interface seven layer model. My students were working closely with me so that they had clear understanding of the working of the model. This enable them to divide the complex communication task into smaller manageable parts. They defined clear protocols between the two programs and they stick to their design and modified the protocol only when necessary.

IMPLICATION FOR IT COURSES

IT courses are becoming popular every day. It seems to me that different people have different interpretation of what IT should be. However, I see IT from another angle. From whatever prospective, there must need somebody who understands telecommunication in sufficient deep to write software for layman use, to maintain the software and to keep the technology advancing.][net is a data network. It is designed solely as teaching network from which students can have real and practical experience in networked situation. However, the low construction cost, the ease of use and the ability to write program which runs on top of the network opens new ground for the students and this puts][net into a class of its own. I have not heard of any local area network with equivalent features. However, working alone cannot do much. It is my sincere hope to share my effort with anyone interested. If you are interested to obtain a copy of the software and the instruction to build the hardware, please do not hesitate to write to me. I am just too happy to share. Your comment will be most encouraging.

EARLY INTERVENTION USING AN INTERACTIVE VIDEODISC

E.Don Nelson, Pharm.D.* , Valerie K. Schorr, M.Ed.*, Jeffry Gordon, Ph.D.**, Glenn Markle, Ed.D.+, Joseph Rauh, M.D.++, Ellen Marino, B.A.˜, and Earl Siegel, Pharm.D.*.

ABSTRACT

An interactive videodisc program for intervention with substance abusing adolescents has been developed. The program is designed to "model" effective decision making and resistance skills in order to gracefully say "no" to the offer of alcohol or other drugs. The program is presently being field tested with high risk youth. Evaluation data will include changes in adolescent knowledge, attitudes, and beliefs towards alcohol and other drugs.

INTRODUCTION

The interactive videodisc program, "Adolescents and Alcohol", has been designed to help teach and reinforce the social skills, knowledge, and decision making skills needed to refuse the offer of alcohol or other drugs. This functional program consists of various simulation vignettes which will model resistance behavior (saying "no" gracefully to the offer of alcohol and encouraging others to do the same). Each of the simulation vignettes give the adolescent viewer the opportunity to "interact" with the video in "real life" situations in which the video character is being pressured by his/her peers to drink alcohol. Coping strategies unique to each simulation vignette are suggested and the viewer must decide what he/she thinks is the best coping strategy for that specific situation. Peer lead discussions of the pros and cons of each strategy in each situation are also provided. This form of interactivity between the adolescent and the program allows the adolescent to receive immediate feedback to their selected "strategies". This interactive videodisc program will allow the adolescent (a) to practice and enhance social and decision making skills in dealing with potential substance abuse situations, (b) to apply their knowledge about the hazardous effects of alcohol, and (c) to examine their attitudes and beliefs towards substance use/abuse.

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OUTLINE OF STUDY AND METHODS

A total of approximately 200 high risk youth representing five social service agencies will participate in the field testing of the interactive videodisc program. The total population at each test site when possible will be randomly subdivided into two groups.(An experimental group and a control group). The control group will not be exposed to the videodisc program. Both groups will complete the evaluation questionnaire before as well as after the program is implemented (1 to 2 weeks prior to and 1 to 2 weeks after). Length of exposure of the program in each site will vary ranging from 4 to 12 weeks. Data analysis will include several analyses, namely, multivariate and repeated t-tests.

HARDWARE/SOFTWARE

The hardware/software necessary to implement the program include a Pioneer^R 601GA Laserdisc Player, an IBM PS/2^R system with a touch sensitive monitor, and an IBM Infowindow^R software package. Commercial distribution of the videodisc is being explored.

RESULTS

The results from the field testing are expected to be ready for publication by fall of this year.

This project was supported in part by the Office of Substance Abuse Prevention (OSAP) Grant No. 5H84D00868.

COLOR MICROFICHE: WHAT ITS FUTURE HOLDS

R. L. Arnold*

ABSTRACT

Color microimaging technology has not yet achieved the market impact as an information storage and retrieval medium that its potential suggests. This is due to previous high cost of color microfiche, inappropriate marketing strategies, the inconvenience of using currently available fiche readers, and the overshadowing of electronic imaging.

In comparison with compact disc technology, microfiche are far less costly and time-consuming to produce and view and offer a tremendous advantage in resolution. Recent developments have reduced the cost of microfiche production while increasing the quality and image density of color fiche. Computer-interfaced fiche viewer/projectors allow immediate random access to thousands of clear, detailed images and simultaneous digitizing of the photo image for manipulation within the computer. Systems utilizing color fiche, automated retrieval, and computer interface can fulfill the need for interactive, individualized, visual learning opportunities.

INTRODUCTION - THE PAST AND PRESENT

So much is being said these days about the promise of electronic imaging, one wonders if conventional photography has a future. More specifically, one wonders about the future of color microfiche as an information storage and retrieval medium and an audiovisual medium. Although the potential for color microimaging technology, especially microfiche, has been clearly demonstrated in the marketplace, it has not enjoyed the far-reaching impact that its potential suggests. Why is this so? A discussion of several reasons follows.

1. The cost of color microfiche has been high compared to black and white microfiche because production has, until very recently, been a labor-intensive process requiring skilled technicians and expensive equipment. A typical production cycle consisted of composing a master by exposing film in a planetary camera, trimming the processed film, and "stripping up" the rows of film on a frame designed to align the columns of images. Then the stripped-up master was printed in contact with 105mm duplication film. Newer step-and-repeat cameras position the images directly onto the mastering film through the lens of the camera; the masters are then reprinted in contact duplicators. These cameras were designed for black and white 105mm films. Color films, which have softer emulsions, tend to be damaged in

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all but the most expensive versions, which cost over seventy thousand dollars. Thus, typical charges for mastering are $2.00 per image and $2.50 for each duplicate fiche.

2. The progress of color microfiche in the marketplace has undoubtedly been slowed because of the fact that color fiche production houses, beginning with Kodak in 1967, positioned microfiche in the micrographics markets, to serve the same clients being served with less expensive black and white fiche. Yet color is crucial for some applications in training and education. "Unfortunately, neither the suppliers nor the users of micrographic materials have actively pursued the training market nor spent much time looking for ways that microforms can solve common training problems" (ref 1). Some notable exceptions exist, including the Yale University Medical School (ref 2).

3. Displaying color microfiche using conventional readers, which make alignment difficult, has discouraged its use. "The microfiche format, however, lends itself to automated alignment systems, making it ideal for training applications" (ref 3). In the 1970s Revox Systems developed a reader/cassette-recorder combination that provided accurate synchronization of a cassette sound track with any image on a fiche. The price of Revox's Audiocard was much higher than that of existing sound-synchronized slide or filmstrip projectors. Several other companies have since developed and marketed automated fiche viewing equipment.

4. Compact disc technology has captured the attention of the micrographic and audiovisual fields due to its huge capacity for data storage and random access retrieval. Ofiesh (ref 4) wrote, "The compact disc can now serve as a storehouse for still and moving video images, graphics and stereo-based audio signals, all of which are digitized. The presence of this new technology in the marketplace makes the educational technology environment positively volatile." Bogue (ref 5), however, put the compact disc into economic perspective:

> Production of a CD-ROM is a complex task, requiring many data-preparation steps prior to the actual manufacturing of the disk master....Duplication of a CD-ROM is also complex, time consuming, and costly.... Costs for production of a CD-ROM range from $10,000 to $40,000 and up. The master setup charge ranges from $4000 to $7000 and duplicates are priced at around $7.50 each in quantities of 1000....To retrieve information from a CD-ROM the user requires a PC, CD-ROM disk drive, interface card and software specific to the CD-ROM format. CD-ROM drives [cost] $1000 to $3000.

Electronic still photography has advanced rapidly.

> In theory, thousands of still images could be electronically recorded, then shown on a home television set. In practice, disks--which are reusable--are currently limited to a maximum of 50 images each....It will still be a long time before the image quality can compete with photography film images (ref 6).

Discussing appropriate applications for compact disc technology, Bogue observed that CD-ROM is a useful medium for distributing infrequently updated information, such as large databases, to the masses (ref 7).

THE PRESENT AND FUTURE

Also lost in the mystique over electronic imaging technology is the fact that a tremendous gap in pixel content exists between conventional and electronic photos. Engineers are improving television monitor screens, on which perhaps a million pixels could be displayed, compared to the 200,000-300,000 pixel content of most home television sets today. A 35mm color image provides up to 25 million pixels, a 110 color image 2.5 million pixels, a disc photo 1.5 million, and a state-of-the-art electronic camera about 280,000 pixels (ref 8). An image on a color microfiche has 30 to 60 million pixels, depending on its format.

A number of other developments in microimaging technology have greatly increased the attractiveness of color microfiche as an information storage and retrieval medium. Major strides have been made in improving the quality and image density of color fiche. Several hundred color images can be formatted on a single four-by-six-inch fiche.

A formatting camera has been developed that converts 16mm and 35mm images to 105mm fiche in one easy step. The camera duplicates masters optically; because each "duplicate" is actually an original, the highest possible quality is obtained. Inexpensive step-and-repeat cameras have been developed that do not damage color film. These innovations streamline the fiche production process, significantly cutting costs. Additionally, new step-and-repeat cameras have solved the problem of precise location of images, making automated retrieval reliable and accurate.

Working prototype of less expensive, high quality computer-interfaced microfiche viewer/projectors have been built and tested. The new generation viewer/projector will allow random access to banks of fiche at the touch of a computer key, clear and detailed images delivered precisely to the screen, simultaneous digitizing of the photo image for ease in manipulation within the computer, and teleconferencing and networking capabilities. These innovations will generate applications in many fields

A key aspect of learning is visualization. Education and training systems utilizing visual media have been developed, tested and used successfully. The full educational potential of these systems is attained when they can depend on the delivery of high resolution color images to the screen via random access retrieval equipment. These systems will enhance the use of the growing number of computers, already over two million, in use in classrooms. "CD-ROM and CD-DVI derive strength in the educational arena from the fact that they expand the capability of the microcomputer which is already deeply entrenched in the educational system" (ref 9). The interactive microphotographic imaging technologies of color microfiche and random access retrieval and viewing equipment have the same strength, along with cost advantages and superior pixel content, and will fulfill needs recently recognized by professional educators.

> Color microfiche is being used as an active communications medium as well as a storage medium for color information. The principal applications include education and training, marketing and advertising, cartography, libraries, micropublishing and engineering, medicine and biology, cataloguing and identification, and scientific applications. The U.S. market for color microfiche is expected to grow at about 25 percent per year. Microfiche offers distinct price advantages over other publishing or communication alternatives (four-color print, slide shows, video disk) when small runs are involved (10,000 or less).... [Color microfiche] is by far the most universal and flexible color micrographic medium. It offers fast retrieval, compact storage and easy handling and has a very wide range of applications. (ref 10)

RECOMMENDATIONS

Now that high quality, high image density color microfiche can be produced inexpensively, be made readily available, and be viewed comfortably on a screen, controlled by computer commands, their innumerable, varied and extensive potential uses will have to be demonstrated. To transcend the current aura surrounding the new electronic technologies and reverse the misleading poor reputation of microimages brought about by their past expense and inconvenience, the following steps are recommended: an international symposium to stimulate awareness of the interactive microphoto technologies available today; research studies aimed at furthering the use of microfiche in education and training; demonstration projects such as the utilization of color microfiche in the preservation and use of the documents of history; and widespread promotion, including professional articles, newsletters, and information networking.

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LAB CONFIGURATIONS: THE HARD CARD/HARD DISK OPTION

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ABSTRACT

Hard card/hard disk configured workstations are suggested for an educational computer lab environment as an option or as a supplement to a network. Software can be loaded onto a hard card or hard disk, such as a 20 Mb, for transfer to each computer configured with a hard disk. If the software is loaded to a hard card, the use of a DOS shell, such as XTree, will provide easy transfer of the files and subdirectory structure to the hard drive. Stored programs can be accessed via a series of nested menus. Printing is accomplished by use of an auto polling print switch. Hard card/hard disk configured workstations have many advantages, including economy, software availability, and relative ease of operation. In addition, the hard card/hard disk configuration does not exclude the installation of a network.

INTRODUCTION

Many options regarding lab configurations can be used to provide access to microcomputers in schools. Popular microcomputer lab configurations include the following:

* a network with terminals
* a network using micros as terminals with floppy drive(s)
* standalone micros with only floppy drive(s)
* micros with floppy drive(s) and/or hard drive/hard cards configured either as standalones or networked

The latter configuration is the option discussed in this paper as used at the Fort Knox Community Schools, a K-12 (U.S. Department of Defense) school district. In the school labs a workstation consists of a MS-DOS compatible microcomputer with 640 K of DRAM, one or two 5 1/4-inch 360 K drive(s), a 20 Mb hard card, and a medium resolution color monitor. If the 5 1/4-inch drive becomes obsolete in the near future, then this drive can be changed for a 3 1/2-inch drive. However, the 3 1/2-inch drive can also be added to the computer while retaining the 5 1/4-inch drive to access any files that have been previously purchased or archived. The microcomputers can be either IBM PC or XT compatibles with 8088, 8086, or 80286 CPUs. If a particular requirement, such as AutoCAD, uses up too much of the 20 Mb disk, then a larger size such as 40 Mb or 68 Mb can be used.

At the Fort Knox School labs, an auto polling switchbox is used rather than the usual A-B-C, etc. channels which require a human controller to operate. In the elementary schools each MS-DOS lab has thirty workstations and three printers. Five auto switches (six stations into a switch) then twice two switches into another switch (piggyback) give twelve stations to one printer and the other six stations to a printer. This setup

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accommodates such applications as newspaper, literary magazine, and teacher-prepared materials. The printers used have either no or very little buffer. Therefore, an external buffer is used so that the station may continue with an educational activity while the file is being printed. In the K-8 grades a 64 K buffer is used. The above configuration is also used at the high school with six machines to a printer with 128 K of external buffer. Such a setup supports programming and word processing classes. In the CAD lab, printing is not a major concern as very little printing is required. In this lab every two workstations have a plotter, which has proven to be adequate.

HARD CARD/HARD DISK ADVANTAGES

The hard card/hard disk configuration is a cost effective choice for school districts. If a configuration is chosen in which the only cost is that of the workstations and the needed printers, the setup is much easier to initiate. If the configuration includes a network, then the overhead expense of the host and the file server has to be financed before any workstations are in place. With the hard card/hard disk configuration, school districts can add workstations and/or printers to the lab over a period of years.

Another advantage to the hard card/hard disk configuration is a higher probability of troublefree operation. In a network, if the host is not the same unit as a workstation and contains a different CPU, motherboard, and daughterboards, any malfunction of the host will cause the network to be down. Thus valuable instructional time is lost. Of course, computers will occasionally have down time. The hard card can be switched from computer to computer in a very short time without any difficulty. The changing of a hard drive is much more tedious and time consuming.

The hard card can also be set up in such a manner that the hardware of the microcomputer becomes almost transparent to the end user. Also, access to instruction is easy and fast, especially for students in the lower grades. Speed in booting and accessing programs is an important consideration because more time is left available for instruction. Microcomputers with a fixed disk can be set to auto boot on power up. The bootup will load any memory resident programs, such as Sidekick, that the students might need. Some memory resident programs, for example, ZIP code, need not be loaded every time. The decision for the fixed disk configuration needs to be made by the professional computer staff in conjunction with the end user. This is necessary as some memory resident programs occupy a large enough block of memory to prevent some programs from functioning, such as the dictionary in Microsoft Word.

To provide a friendly user interface, a series of nested menus are used. The main menu is loaded via the autoexec.bat files and gives the end user the choice of the submenu(s) appropriate to their needs as well as the exit choice. Since it may be very desirable to prevent most end users from entering the system, the menu will not allow the choice of DOS and any exit from a program will automatically return to the menu. With this structure, a custom menu structure can be built for each lab. All the entries are entered by the user as one or two keystrokes to identify the bat file that will load the appropriate file. At the end of using this file, the user is returned to the main menu.

The illustration below is the menu organization for an elementary school:

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THE MAIN MENU

1.  Keyboarding
2.  Language arts
3.  Mathematics
4.  Programming
5.  Science
6.  Social Studies
7.  Word Processing

9.  Exit

ENTER YOUR CHOICE ______
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The illustration below is a submenu for word processing:

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WORD PROCESSING

1.  Enter text
2.  Save a document
3.  Load an existing document
4.  Insert characters
5.  Delete characters
6.  Move/copy a block
7.  Delete a block
8.  Set margins
9.  Windows
0.  Return to MAIN MENU

ENTER YOUR CHOICE ______
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A master hard card has been created for each level--K-4, 5-7, and 8-12. For the organization of the hard card, each option of the submenus are stored in their own subdirectory for easy file management. This is needed since both teachers and students have saved files to the hard card that could have been saved to a personal floppy. The bat files to access the choice of the menus are located in the root directory.

This master hard card is created with the appropriate menus and all the needed files. If major additions are required during the school year, these changes can be placed on a hard card that can be mounted in the workstation to update the workstation's hard card. If the additions are minor, however, this can be accomplished from floppies. For this reason, the XTPRO program is loaded on every station for use by the Computer Department personnel. The only way to access this program or any program not listed via the menus is to boot from a DOS on floppy. To prevent unauthorized access, the floppy version is not left in the lab, only in the Computer Department.

CONCLUSION

The use of a hard card in place of a network for the selection of files via a menu system eliminates the need for a complex host, large hard disk or tower, wiring, and the problems related to networks. Also, the availability of the files is not dependent upon one dedicated host. If the need arises, a station can be moved from the lab or a regular classroom; a move much more difficult to accomplish with a LAN. If funds are available for the large, comprehensive educational packages, then a network can complement this hard card configuration.

ATTRIBUTES OF CD-ROM FOR EDUCATION

Carolyn J. Kuhn*

ABSTRACT

CD-ROM (Compact Disc-Read Only Memory) is an important new mass storage peripheral device for microcomputers in educational settings. It provides read-only access to large quantities of text, images, audio, and multimedia information that can be used at a standalone workstation or in a networked system. CD-ROM applications are valuable reference tools and create new environments that can approximate experiential learning and enable multilingual knowledge transfer via multimedia databases. Publishers and educational users must communicate and work together so that educational titles can be designed that fulfill the promise of this distribution technology.

THE CD-ROM PERIPHERAL

Optical storage technology is not new. It is a means of storing large quantities of information in a small space at a fairly affordable price. Available worldwide since 1985, CD-ROM (Compact Disc-Read Only Memory) utilizes a 4.72 inch CLV laser disc. The early agreement upon standards for the physical characteristics of the disc and player have enabled this storage medium to be widely adopted by microcomputer manufacturers as a mass data storage device. CD-ROM drives are available today for most popular PCs, the Apple Macintosh$^{(R)}$, Apple IIGS$^{(R)}$, and Atari ST$^{(R)}$, to name a few.

As a peripheral mass storage device, the CD-ROM drive may become as important a milestone to future information processing as the floppy disk is recognized today. A single CD-ROM has a capacity of 600 Megabytes. A single disc can, therefore, contain 250,000 pages of text, or 1500 full floppy disks, or 74 minutes of CD Audio, or a few thousand images, or a combination of all these things. Via the microcomputer, desktop, or portable, all of the application database is accessible in two seconds or less.

The CD-ROM medium provides an immediate opportunity to have access to large databases on demand. Databases that were accessible only via expensive mainframe links or on-line services a short time ago can now be purchased and used locally with a PC. This improvement in access and distribution of information enables knowledge transfer in many professional, business, and general subjects worldwide.

CD-ROM is a read only medium. Publishers can distribute material intact without fear of data loss. Information on a CD-ROM disc can be accessed via network or at a standalone workstation. Teachers and students can use databases on CD-ROM without fear of a wrong keypress that might erase information. Laboratory tests suggest that CD-ROM discs have a life in excess of 10 years.

The importance of CD-ROM technology lies beyond its physical attributes.

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It is a conduit for a new kind of application. At an elementary level, these may be databases of full text research articles or legal documents, or reference materials, lesson plans, etc. Each of these examples is an excellent use of CD-ROM. Teachers, school administrators, and students are benefiting now from CD-ROM applications like PRAVDA from Alde Publishing, K-8 Science Helper from PC-SIG, the Texas Education Encyclopedia from Quantum Access, Inc., and a long list of other bibliographic and text references.

New and experienced computer users enjoy using CD-ROM programs. It is easy to get information and interesting to browse. All of the information is randomly accessible via search and retrieval software designed for the database. Tools may include topic searching, key wordsearches, a variety of word and topic indices, and Boolean operators.

MULTIMEDIA CD-ROM APPLICATIONS

The full potential of CD-ROM databases lies in combining multimedia material on the compact disc. Affordable PCs like the Tandy(R) 1000 series, the Apple Macintosh and IIGS, and Atari ST, are excellent multimedia platforms that support color and black and white images and animation, digitized sound and CD Audio via the CD-ROM drive, text and data retrieval, display, and output. All of these forms of information can be combined in a single CD-ROM application.

Multimedia applications on CD-ROM create new and exciting environments for learning, reference, and entertainment. The ability to interweave images, audio, and text draws the user into the experience in new and effective ways. The impact of multimedia can also be enhanced by links between data elements so that users can explore between topics, greater levels of depth on a topic, or supplementary materials and presentations.

The Facts On File(R) News Digest by Facts On File, Inc., combines eight years of full text news summaries with a collection of over 500 maps. Users can research news topics and locate places, demographic information and trace important events via this rich collection of material. It is an interesting way to learn geography as well as current events. In the StarDate presentation, "Worlds of the Solar System," on Apple Computer's CD-ROM Explorer disc, users can visit the planets and Earth's moon in the solar system. Audio narration, images, and animation are combined to describe characteristics of each world and interesting facts.

Finally, CD-ROM databases can be designed so that educational materials can be distributed in several languages. For example, you could have 5000 pages of text and graphics in five languages and twenty minutes of audio narration as well, in each language on a single disc.

The Visual Dictionary prototype CD-ROM by Facts On File, Inc. shows how multimedia and multiple languages can be combined to create a new environment for learning vocabulary. Users can access information by picture or word. Audio pronunciation is available on demand. Menus can be presented on screen in the user's native language or target language. Audio help provides immediate descriptions of all search and retrieval tools thereby doing away with the need for an extensive technical manual. And, data from the disc can be selected and loaded into a companion drill and practice software module.

CD-ROM is an important peripheral mass storage device because it provides local access on demand to large quantities of information affordably. Applications on CD-ROM are valuable productivity tools in education for professionals, administrators, and students. The development of multimedia and multilingual databases on CD-ROM is an important new development in knowledge transfer. These applications approach experiential learning and stimulate curiosity through the combination of presentations, media, and flexible navigation tools.

Exploiting the promise of CD-ROM will not occur by itself. The stakeholders of the educational process--educators, students, publishers, and producers--must become more involved together with the technology. The hardest and most pressing dilemma is what content should be distributed on CD-ROM. Encyclopedias and textbooks may or may not be the best use of CD-ROM. Designs of database structures and retrieval systems need to embody those things that create an environment that will affect the user in productive ways. This requires direction from the educational market, thoughtful collaboration, and excellence in design and production.

DEVELOPING AN INTERNATIONAL DISTANCE LEARNING PROJECT

Daytra Hansel*

ABSTRACT

The University of California, Los Angeles (UCLA) is currently developing a three year distance learning pilot project in applied linguistics with the Beijing Applied Linguistics Consortium (BALC)** in Beijing, China. It is scheduled to begin in October, 1989.

Planning and implementing such a project involves considering many key issues, some of which this paper presents.

** BALC comprises the English Departments and English Language Centers of the following: the Graduate School, University of Science and Technology of China; Qinghua University; the People's University of China; Beijing Normal University; the Beijing Institute of Aeronautics and Astronautics; Northern Jiaotong University; and Beijing University of Iron and Steel Technology.

INTRODUCTION

A UCLA-affiliated program presently provides instruction in applied linguistics to BALC graduate students. One faculty member per year has been going to Beijing to act as lecturer and thesis advisor. To expand the availability of instructors and courses, UCLA and BALC have decided to use a teleconferencing system for distance learning. The system will provide for interactive instruction between UCLA and BALC three hours per week each semester.

The project's goals are:

1) to use a computer-based, audiographic/video teleconferencing system to expand and enhance the existing program in Beijing by offering additional applied linguistics courses and lecture series, and
2) to evaluate the effectiveness of distance learning using the delivery system.

Once the project begins other UCLA academic departments will have the opportunity to use the system and participate in educational exchanges with BALC. One European and another Asian university are interested in joining the network as well.

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SELECTING THE TELECONFERENCING SYSTEM AND INSTRUCTOR TRAINING

Selecting the most appropriate delivery system was a major focal point in this project's development. After considering the variety of courses and presentation requirements for applied linguistics--as well as other academic departments which will use the system--a computer-based, audiographic/video system was chosen for both sites, a speakerphone or audioconferencing system will be used in conjunction with the system.

The system has been used before in Beijing; therefore, certain obstacles will be avoided, such as obtaining permits to use the system in China, determining electrical regulations, and video standard requirements for the camera and monitor.

The system is quite flexible and provides instructors a number of presentation options. It operates in real-time using one or two standard dial-up telephone lines. One line can be used for simultaneous voice, computer, and electronic tablet transmission, a second line for color still frame video. Video images can be taken from a camera, videotape recorder, or Camcorder, stored in the computer, and accessed for presentations. Real time interaction is provided by overlaying tablet-based color annotation and/or computer-based text on both graphics--generated by the computer--and video images.

The instructor may opt to use one, two, or all of the following during a presentation: the computer and software, the electronic writing tablet, and/or still frame video. Additional aids may be used, such as audio cassette tapes to listen to speeches by prominent scholars, and videotapes to view experiments and demonstrations.

Preparing instructors to use this multi-faceted system requires training which will be provided on an ongoing basis. Beginning in April, training will be available on an individual basis as often as needed. After the instructors have become familiar with the system and had the opportunity to prepare sample materials, they will find the style of presentation that best suits them and their course materials.

UCLA will prepare a handbook describing the delivery system and how to use it, general administrative issues relating to the project, and tips and references from instructors who have used the system for different distance learning projects.

COURSE SELECTION

Instruction will be in courses presently unavailable to

BALC students. Several courses have already been identified, and others will be selected by mutual agreement of the participating institutions.

INSTRUCTIONAL MATERIALS

Instructional materials will be determined by UCLA faculty with input from BALC faculty. The appropriate materials will be designed to employ with the various functions of the delivery system. There will be a software package available for the computer, which provides a number of options. In some instances assistance may be needed from a specialist, such as a graphic artist, to produce the most effective materials.

Throughout the project instructional materials will be carefully studied for quality and effectiveness and adjustments will be made as needed.

INSTRUCTOR RECRUITMENT

Because of the interest in the project, instructor recruitment will not be a problem. Already several instructors desire to participate. However, extra time may be required to prepare course materials, meet with students via computer and/or audioconferencing, and, initially, to work with BALC members to design courses and materials, determine course requirements and prerequisites, testing procedures, and course and instructor evaluations. To compensate for these additional duties and as an incentive to retain faculty throughout the project, a stipend will be provided for each course or lecture taught.

CULTURAL DIFFERENCES

Considering cultural and social differences are important--especially for presentations and interactive exchanges. A concerted effort will be given to provide for educational exchanges that reflect an understanding and appreciation for cultural diversity.

SUPPORT SERVICES

Timely and well organized support services are important to this project's success. BALC students should be made to feel a part of the UCLA community by having access to similar services. Student orientation sessions will provide students with the opportunity to become acquainted with the delivery system and general procedures before classes start. They should be able to meet to discuss questions or problems with their instructors outside of class hours--audio and/or computer conferencing can be used to accomplish this quickly and effectively. Class assignments and tests can be managed by mailing materials in a timely manner, and the computer, the tablet, and audioconferencing can also be effective--

especially for informal situations. Similarly, resource materials can be mailed ahead so they are received in time for class assignments and some may be prepared on the computer, transmitted, and printed as needed.

A practical system for student registration and similar administrative procedures will be developed to insure efficient access to courses.

PROJECT EVALUATION

Systematic monitoring and formative evaluation will be ongoing to appraise the quality of the project. Measurement instruments will be developed to determine the extent of student learning, and the efficiency of the delivery system, instructor presentations, course materials, and support services. A yearly report will describe the project's progress, and suggested changes will be noted for the next academic year.

CLOSING COMMENTS

Although this paper describes just a few key issues, the enormous potential for the study and advancement in international distance learning should be apparent. This pilot project's success could point the way to an expanded network involving colleges and universities from many countries participating in educational exchanges on any number of subjects. The opportunities for truly innovative international/intercultural exchange are particularly exciting, especially as distance learning continues to evolve into a viable means of providing education.

Dr. Russell Campbell, Director, UCLA Language Resource Program and the author are jointly developing and administering this project.

PAPER-FREE, WALL-FREE UNIVERSITIES OF THE FUTURE

Charles Kanyarusoke*

ABSTRACT

Increased demand for college education in the twenty first century will soon be reality. A rationale is given for a paper-free, wall-free, electronic university. In its finest form, the electronic university will have no residential campuses, no rigid class schedules, no paper work, and no limit on enrolment. The basis of its operation will be telecommunications technology.

INTRODUCTION

There was a time when "the future" was 1984. That is now the past. Today, the future could be tomorrow, or the twenty first century; but whichever way we look at it, the future is here. The next century is going to be of great significance to higher education in general, and college education in particular, because a college degree will be the passport to most entry level jobs. Times are gone when a high school diploma was sufficient for jobs like messenger, store clerk, automotive technician, etc. In the twenty first century, a college degree will be the minimum qualification for such jobs.

Increased demand for college degrees, coupled with the coming of age of the children of the baby boomers, will make the provision of college education a real challenge in the twenty first century. Today's paper-pushing, bureaucracy-ladden, and limited-enrolment universities will not be able to meet this challenge. Universities will be as numerous as high schools are today, making state-supported universities a rarity. In the true spirit of free enterprise, universities will be impelled to operate like any other business. They will have to be self-sustaining, posting a positive input to output relationship, while offering a quality education.

RATIONALE FOR ELECTRONIC UNIVERSITIES

In order to survive as free enterprising concerns, universities of the future will have to make their services affordable to the average student. Like grocery stores, in order to maintain a positive input to output relationship, they will have to rely on volume sales rather than cost per unit. They will have to boost enrolment while dramatically reducing custodial, administrative, and even academic personnel. They will have to get rid of most of the paper work that requires hordes of clerical and bureaucratic personnel. They will have to find ways of having unlimited enrolment without constructing new classrooms, science laboratories, dormitories, etc. This calls for the concept of a paper-free, wall-free, electronic university.

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BENEFITS TO PROVIDER AND CONSUMER

The electronic university will offer benefits to both providers and consumers of college education. It will not require extensive campuses as we know them today. It will be non residential, with no on-campus students. There will be no traditional classrooms, seminar rooms, or lecture theaters. Great savings will be realized on building construction, maintenance of physical plant, heating, lighting, security, etc. There will be no need to put a cap on enrolment since there will be no classrooms to fill. A university will be able to enroll as many students as needed to maintain a positive input to output relationship. One professor will be able to lecture to an unlimited number of students via telecommunications networks. The faculty payroll will finally reach a low ratio to incoming fees.

Benefits to the consumer may be summed up in one word, convenience. One will be able to take college classes in the comfort of one's home, following a flexible schedule. Every home will be a potential college classroom. Long commutes to school, traffic jams, bad weather, night driving, etc., will all be things of the past. Rigid class attendance schedules and lockstep completion of course work will no longer be the trend. A student limited to one region of the country due to family or job obligations will be able to "attend" a college of his or her choice anywhere in the country, without disrupting family or employment arrangements. There will be a great variety of colleges to choose from as there will be no regional barriers or extra tuition for out of state students. Flexible scheduling made possible by electronic universities will enable parents to stay home with their young children, or anyone to hold a full time job while pursuing a course of studies.

THREE LEVELS OF ELECTRONIC UNIVERSITIES

Three levels of sophistication are envisioned, low, intermediate, and high. The level of sophistication is defined in terms of degree to which the operation is paper-free and wall-free, maximum enrolment capability, sophistication and cost of technologies utilized, variety of academic programs, and level of professor-student interaction. The operation, at any level, will be based on carefully designed telecommunication systems. The American university system will be used as a point of reference for all examples and suggested system configurations in this presentation. Models will be suggested for selecting a college, submitting an application, admission procedures, registration for classes, billing, class attendance, and professor-student interaction.

SELECTING A COLLEGE

College selection procedure will be standard for all three levels. A national college data bank (NCDB) of all universities will be built. Every university in the nation will be featured, showing its range of academic programs, admission criteria, tuition charges, etc. The data bank will be accessible from any post office. For the sake of convenience, it will be a dial access data bank, which a prospective student may dial up on his/her home computer, via ordinary telephone lines. Link time charges will be assessed and added to the user's telephone bill.

APPLICATION AND ADMISSION PROCEDURE

Applicaton and admission will involve no paper work. Every high school or college preparation institution will maintain a data bank of current credentials for every student. A student seeking admission to any college will dial up, through a modem, the admissions computer at that college. The student will indicate that admission is sought, then enter his/her biographic data, including a code number for the school where his/her credentials are kept. The admissions computer will dial up the prospective student's credentials and compare them to the college's minimum admission requirements. The student will receive online admission or denial, followed by a confirmation letter.

COURSE SELECTION AND REGISTRATION FOR CLASSES

The student will first decide on a major area of study, then dial up the university curriculum computer to access course prescription for that area of study. Next, the student will dial up the computer in the department of his/her major to find out which of the courses in his/her major are being offered that semester. Having determined the courses to take, the student will enter the selection, followed by the student's bank account access code, directly into the registrar's computer. Online acknowledgement will be received, followed by a confirmation letter. The registrar's computer will automatically transfer the appropriate amount of money from the student's bank account, for tuition. The student's bank computer will send the student a debit note by mail.

CLASS ATTENDANCE AND PROFESSOR-STUDENT INTERACTION

Class attendance and professor-student interaction protocol will vary depending on level. At the low level, a multipoint distribution microwave system (MDS) will be the backbone of all instructional communication. A cluster of homes or other special college classroom centers, will be linked to a regional university via MDS microwave. Each regional university will be capable of serving a fifty mile radius area. Instruction will be provided through one way, live video and two way audio. During live class lectures, students will be able to see and hear the professor, and be able to ask or answer questions through telephone line audio links. A student may opt to record the lecture for later review. Depending on the number of homes linked to the system, one professor will lecture to thousands of students, maximizing input-output relationship. All assignments will be sent to the regional center where they will be graded by professor aides.

The intermediate level electronic university will attempt to cover a service area greater than that covered by the low level one. The telecommunications technology involved will be a combination of two way, augmented audio conferencing and one way freeze frame video. Both images and audio will be transmitted via telephone networks. A student will be able to attend live lectures by direct audio link, and to see stills of the professor or other illustratory material via freeze frame video images sent over telephone lines. Line illustrations and simple chalkboard sketches will be directly transmitted to the student's video monitor. A student may opt to videotape a lecture for attendance at a convenient time. It is possible, at this level, to operate a nationwide network of classes, with one professor lecturing to millions. Assignments will be sent to regional centers for grading by professor aides.

The high level electronic university will be purely paper-free and wall-free. It will utilize sophisticated satellite transmission, one way, full motion video, flexible scheduling, and automated testing. A student's home work station will consist of a roof-top satellite receiving antenna, a computer with a receiver-transmitter keypad, a television receiver-monitor, a video cassette recorder, and an optional facsimile receiver-transmitter. The nucleus of the operation will be a lecture origination center, equipped with satellite transmission and receiving systems. A direct broadcast satellite (DBS) will be launched to allow direct broadcast of lectures into homes within its footprint.

Live transmission of lectures in different areas of study will take place simultaneously, with each area of study transmitting on a different frequency. A student may opt to attend live lectures, or program his/her video cassette recorder to tape them for attending at a convenient time. The video transmitted will be full motion, allowing the telecasting of detailed, live demonstrations. Students may ask or answer questions during class, or through electronic mail. For students who wish to accelerate their pace of college study, prepackaged lectures for any of their courses will be available in the university's dial access video library. By entering the code for the lecture needed, the lecture will be played back for the student.

Examinations for any course of study may be taken at the student's convenience. A mastery approach will be employed. A student will indicate readiness to take the examination for a particular course. The examination will be computer administered in interactive mode. The student will take the examination in the comfort of his/her home. Scoring of the examination will be immediate. The student will be awarded a grade and corresponding quality points. If the student fails the examination, he/she will be allowed to take an alternate form of the same examination in which none of the questions will duplicate those in the examination previously taken. All examination results will be kept on the students academic transcript. A student may dial up his/her transcript for examination. The transcript will be copy protected to discourage tampering. When graduation requirements are fully met, the registrar's computer will cause notification to be mailed to the student. A diploma will shortly follow.

CONCLUSION

The concept of a paper-free and wall-free university, or simply an electronic university is not far fetched. The technology for its realization at various levels is here and improving. Does this imply advocation for universities that exist only in the mind of a computer? Certainly not. The electronic form of university is suggested as an alternative to traditional universities. People who want the warmth and social atmosphere of a traditional university will, and should, be able to attend one. They will, most likely, be paying more for this luxury. Universities, as we know them today, serve more purposes that providing an academic environment where learning takes place. Their role as places where young people grow into mature adults, develop lifelong friendships, even get spouses, should not be overlooked. All I am advocating is that let us provide alternatives, and let us be ready to satisfy the inevitable high demand for quality college education, at competitive rates.

STRUCTURING COURSES FOR DELIVERY VIA TELECOMMUNICATIONS

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ABSTRACT

Preparation of courses for delivery via telecommunications is a very different process from that of preparation for delivery via the traditional classroom situation. Preparation of lectures, graphics, media, and the administration of course delivery are more involved than when teaching courses on campus with students attending in person. In addition, there are two typical models for course delivery via telecommunications. These include Instructional Television and Videocassette. Satellite delivery is becoming ever more popular but very expensive to access. This paper will include information on structuring of courses for delivery via the electronic formats mentioned above, and all three formats shall be referred to by the term electronic delivery.

INTRODUCTION

Information presented in this paper will include suggestions on the practical work involved in preparing courses for electronic delivery formats including television, videocassette, or satellite. All of these formats can be considered distance models for course delivery. Distance Education has become the wave of the future and the answer to an ever increasing problem of the need to provide graduate level education and training to an increasing population of clients residing in highly rural areas of the world.

Coursework in certain highly specialized areas of knowledge or content are often available at only a few institutions of higher education spread out over large geographic areas. Distance Education Models have expanded the availability of graduate training to individuals who would not normally be able to attend the institution for training due to great distances from campus.

TWO MODELS FOR COURSE DELIVERY

Instructional Television Fixed System: Course delivery via this model at The University of South Carolina includes delivery of lectures via a closed circuit television system. Students access the circuit in regional viewing sites. They receive one-way video and have talk back capacity through an audio circuit. Students are able to use a microphone in the on-campus studio or a telephone in remote sites to ask questions or to participate in discussion. The system allows each student to be heard. At other universities in the U.S.A. systems include two-way video as well so that students in remote sites can be seen by the instructor and their colleagues at other locations. This technology is very expensive and not available at many locations.

Videocassette Courses: Courses are developed in The University of South Carolina Instructional Television Department of the Instructional Services Center. Graduate level courses are organized to provide lecture content and demonstration of materials on videocassette. A typical graduate level course includes 37.5 actual clock hours of instruction. For the purposes of teacher-education, the content is divided between videocassette lectures and on-campus practical sessions. Of course, this requires students to be within a three to four hour distance from campus. These sessions are usually held on Saturday to facilitate the attendance of full time teachers who work during the week.

PREPARATION OF LECTURES AND GRAPHICS

When preparing lectures for electronic delivery one must consider the content to be taught. Primary decisions include the possibility of student participation on campus for at least three to four practical sessions on weekends. For the discipline of teacher-education, this is particularly important. The University of South Carolina now provides graduate courses via electronic delivery models in the Graduate Schools of Education, Business, Engineering, Nursing, and Social Work. Most of these programs require attendance at on-campus sessions for several Saturdays spread out across the term. The following decisions should be considered:

1. Divide course content into concepts and materials that can be taught via video. It is surprising how efficiently materials and their use can be demonstrated through this media. The studio must have two cameras, one for full or medium shots of the professor, and one overhead camera that can zoom in and out on materials placed on the desk. Efficiency is gained by adequate demonstration using one set of materials, when demonstration in the regular classroom would require students to "gather round" the instructor (some receiving partial view). The expense of purchasing many copies or sets of materials in order for each student to see the materials is also avoided.

2. When on-campus sessions are possible, activities that reinforce content provided via video should be structured. When developing the syllabus, one must carefully organize lectures and their content to be timed perfectly with on-campus practical sessions. These sessions can be used for "hands-on" work with clients and materials, essential activities for nursing and teacher-education.

3. When graphics are to be used, check carefully that color of print and background project into the color monitor with good resolution. Color changes drastically when filmed. Copyright releases must also be obtained for any copyrighted materials shown on the circuit broadcast or videocassette.

4. Handouts are very helpful to students as much material can be covered on video very quickly. A typical three credit hour course should contain no more than 15 to 20 hours of video. The remainder of class time is generated in class projects, written assignments, and on-campus practical sessions. The material presented in videc sessions is very condensed. This is partly due to the format and reduced time in instructor-student interaction and discussions during video portions of a course. These handouts should be prepared ahead of time and handed out as a package with the syllabus. This requires a great deal of organizational skill as the handouts for the entire semester should be ready and presented at the beginning of the course with the syllabus.

5. While teaching in studio for direct broadcast one must look directly into the camera. If one does not, those viewing the monitor see the top of the instructor's head, or their eyelids! Always speak clearly. Always look directly into the camera lens so that the student is able to look directly at you when viewing. Remember also, if sessions of live broadcasts are taped to be edited for later reproduction onto videocassette, be sure to look directly at the camera for brief pauses of five to ten seconds when in transition from one major topic to another. pause also when finishing a lecture and beginning to discuss "housekeeping" information such as current dates for on-campus sessions or taking roll. This activity can then be edited out later for the purposes of creating useful copies of only the lecture content of a broadcast.

EFFECTIVENESS OF DISTANCE MODELS AND STUDENT SATISFACTION

Student responses to graduate level education delivered via electronic models has been very positive. Overall, the student most likely to appreciate these formats is the one living a distance from campus, and for whom coursework would not normally be accessible. Students express displeasure with the formality of coursework taken via television. They especially do not like to use the microphone in the on-campus studio, or accessing the audio circuit via telephone in remote sites. There is some lag-time between picking up the phone and actually being heard by the instructor in the studio on main campus. This does have an affect on the amount of interaction and discussion duirng television courses.

Videocassette courses are very popular. Students in rural areas are especially appreciative of these courses. The most popular feature of courses sent on videocassette includes the capacity to re-play entire lectures or to rewind to hear specific information a second and third time for learning purposes. Most courses offered via videocassette include not only on-campus practical sessions but also use of a teleconference line. Students can call in and speak to the instructor at a set appointment time each week. Up to fifteen people can access this line at once, although only one person can speak at time. Methods for encouraging students to access and utilize this technology must be developed.

As a rule, the more self-motivated and competent the student, the more satisfied they are with electronic course delivery. Distance from main campus is also a very key factor as well as availability of course work within that state or region of the country. Student acquisition of skill and competence appears to equal or exceeds that found in on-campus sessions.

SUMMARY

Delivery of coursework via electronic models can be very successful in reaching students for whom coursework would not normally be accessible. There are certain practical considerations involved when developing courses that will be delivered via electronic models. Good organizational skills are essential as well a planing of the particular concepts to be taught via video versus during practical sessions. Video techniques such as looking directly into the camera and creating pauses for later editing purposes should be developed. Copyrights must be obtained for all materials displayed on video. As a whole, student reponse to these models has been very good and class enrollments are high, particularly in disciplines for which few training programs are available regionally. Course delivery via electronic models is the wave of the future and a fun an fascinating challenge for the professor.
As an instructor, the key to success in structuring is comprenehsive prior planning and organization.

COMPUTER PALS ACROSS THE WORLD

J Erwin

ABSTRACT

Wouldn't it be great if our students in the United States could write to the students around the world and have the letters arrive INSTANTLY? Well, that's exactly what is happening right now with an international writing project called Computer Pals Across the World.

This project has matched up over 300 schools in Australia, England, Canada, New Zealand, West Germany, France, Japan, Hong Kong and many other countries with schools in the United States in a very unique pen-pal relationship. The main differences between this and other pen-pal systems are that the students -

-write up their messages on a computer with a word processor
-use a modem to call a phone number to access TELENET or TYMNET
-connect to DIALCOM, an international electronic mail system
-send the messages to their sister school's electronic "mail box"
-read any messages that are incoming to their "mail box" from their sister school
-hang up and print out the messages they have received

One of the wonderful things about this project is that it is a great motivational tool for getting students writing to an exciting audience - other students their age half way around the world! It fits into teaching the writing process very well. It also allows teachers from a wide variety of subject areas and grade levels to directly use the computer as an educational tool.

Computer Pals Across the World, USA

Computer Pals not only involves students at all grade levels from elementary school through college, it also has brought very special groups of students together. Students that are deaf, blind, physically handicapped and that have other special needs have broadened their educational experience by communicating with students around the world that share their circumstances.

Whether it involves Eskimo or Indian students from the United States, Maori students from New Zealand, Aboriginal students from Australia or any other unique group that has special cultural experiences to share, Computer Pals Across the World has established an easy-to-use, affordable means for these students to share their stories and questions. And with this direct communication between these young people comes a wonderful opportunity for them to build a better, more friendly world for the future.

This workshop will provide a full day of hands-on participation to learn how to use the electronic mail system for Computer Pals Across the World and how to design a successful program for writing around the world.

NETWORK-MEDIATED EDUCATION AND TRAINING

Lawrie Blackburn, Digital Equipment Co. (UK) Ltd

Networks have established themselves around the world as a major technology of the 80s. Primarily designed for general communication, they offer new capability for distance learning - perhaps allowing distance learning to achieve its full potential. This paper examines a definition of distance learning and then surveys most of the areas where networks can improve the performance of distance learning.

The impact of computer networks on distance learning DIGITAL's network strengths would naturally predispose the company towards the development of powerful technical solutions of interest to distance learning. This paper reviews a number of ways in which network technology is impacting the delivery and style of learning at a distance.

Keegan (1980) lists six characteristics which together define distance learning. Distance learning implies:

1 separation of teacher and learner
2 institution to teach - rather than the teacher
3 use of technical media
4 two-way communication
5 use of group meetings
6 use of industrialised methods of production

1. The majority of teaching and learning activities in distance education are separated in space and time and the administrative infrastructure is designed upon this premise. These features, however, do not preclude face-to-face contact between a teacher and learner which often takes place when remedial or trouble-shooting activity is necessary. The availability of powerful communications has dramatically changed the way we experience the space and time separation.

2. Distance learning is intrinsically mediated learning. The classroom teacher activity used to transfer knowledge and understanding must be transferred to various forms of technical media designed for self-study: print, broadcasts, cassettes, databases, electronic mail etc. Because of the typically wide circulation of these media, great care must be taken in the design and production of these media to ensure effectivity and durability. Print has been by far the most favoured medium for distance learning and this will remain so for some considerable time; more than 90% distance learning courses listed by the UN use print as the main medium of instruction. Computer-dependent network-facilitiated electronic media have now been added to the range of media used including on-line databases for researching, and the use of electronic-mailbased (E-mail) student and tutor conferencing.

3. With distance learning, it is the institution rather than the teacher, who teaches. Courses are nearly always the result of a collaborative effort inside the institution which also distributes and evaluates the course. More and more companies are creating corporate networks capable of being used to deliver distance learning. These companies will need to examine how they will be seen by their employees as distance learning organizations.

4. Two-way communication, traditionally, has been achieved using postal correspondence. More recently, face-to-face and telephone contact has been used widely but with the strong growth of computer networks, E-mail and computer-mediated conferencing, students and tutors should expect a growing proportion of their communications to be handled over the network.

5. Group meetings between students and tutors are easily arranged in campus-based education, in distance education this cannot be taken for granted so group meetings are often carefully planned and they concentrate on only those functions which cannot be mediated through course materials such as remedial work, laboratory and practical work. Group communications for distance learning become easy again using networks but there will still be residual needs requiring physical group meetings.

6. Media production, required for institutes delivering large volumes of distance courses, often have to employ industrial methods to achieve the necessary efficiency: all stages of production (design, development, printing, storage and distribution) using dedicated skilled operators and managers. These skills are typical of those employed in industry not in conventional campus-based educational institutes. Networks will facilitate the collaborative expertise required in media production and may, in the future, actually transform some aspects such as storage and distribution.

See examples 1 and 2 inclusive (DVN training series and Integrated CBI).

Information Architecture (Intelligent Integrated Info (I-cubed)) In order to mediate instructional resources through a worldwide network (Bergersen, 1988) a set of context-dependent information architectures can be devised. Though this development, infor mation, held in a variety of formats anywhere in the world, should be available to a user when it is needed, in the way the user wants to receive it and in a reusable form. To achieve this, considerable use of Artificial Intelligence (AI) techniques is made, in order to assemble information from a wide area network. The important benefit offered by the success of this R&D prototype (Research & Development) will be 'information reusability' in order to avoid expensive intellectual and physical duplication of effort.

Essentially, we are dealing with an architectural problem which will allow us to define and handle:

- data transparently
- any data, any medium
- distributed data and processing
- multiple users
- users' terminology

All of these rely upon a sufficiently coherent information architecture. This is an extremely complex problem to solve because information changes meaning with its context. Each context therefore has an associated architecture. A single architecture will not meet the needs of all users, in general. I-Cubed provides a system for users and organizations to define architectures to meet their own needs. The key achievement of I-Cubed is the integration of multiple architectures to work together in an information environment.

See example 3 and 16 (I-Cubed and Broadband Video Network).

The power of the network

Corporate users are now highly dependent on system functions which require the underlying power and efficiency of a network of computers. Whether it is routine office communication between co-workers or the participation in special interest group (SIG) conferences, the network is an indispensible requirement for the efficient conduct of this kind of activity. As the network grows it will become essential to develop AI-based tools for the effective interrogation and collection of desired information. (Refer to 'I-Cubed' project).

See examples 4, 5, 6 and 7

Collaborative learning

With the advent of low-cost medium and high-resolution liquid crystal OHP plates, video projection of computer-held data is now commonplace and results in an integration of two technologies OHP and video display.

Meetings and small classes may view in comfort text and graphics held electronically either on a local PC or remotely on a mainframe. Fully functional graphics editors also allow interactive update of displayed information giving a new sense of collective power over corporate data. This updated display, holding new perceptions and wisdom of the meeting, may then be instantly netted to any part of the worldwide network, where other groups will receive and perhaps process it further using similar techniques.

In training, this capability is proving extremely motivating. Class groups become well motivated when individuals or the group see displayed information being amended to reflect their under standings. Screen dumps of information developed by groups in this way can be made immediately available during a class for further off-line class work, or be electronically mailed to class members' own accounts for later access.

Without doubt the advent of the affordable multimedia workstation and large-screen videoprojection will cause a revolution in campus teaching and in corporate training departments (Blackburn, 1986). Already, the corporate network permits a strong degree of collaboration in the refining of student work. Group network activity can now produce high quality results by first capturing the individual contributions within the group. The group report may then be passed around for the addition of futher annotations, comments and criticisms before deciding on the final content. The document may then be netted to an external assessor for review before final revision and submission. It can easily be imagined how this scenario may be extended to include voice (e.g. for comments) and graphics and video for a multimedia video presentation to a class.

See example 8 (Audiographic teleconferencing).

Networked systems for tutoring

Undoubtedly, the future of networking is assured when the power of network systems is growing so rapidly. Within a decade we are being told to expect 15-20 MIPS on a workstation and 100 MIPS by the millennium. Today, ATHENA (MIT) learning workstation technology magages with 2 MIPS and is attracting a reasonalbe amount of optimism for the effectiveness of multimedia delivery workstations. In Europe, ATHENA technology has been transferred to a 10-man project centred on DIGITAL's Campus-based Engineering Centre (CEC) at Karlsruhe University. NESTOR (NEtworked Systems for tuTORing) is chartered to anticipate this unprecedented growth in the power of the educational workstation and to provide simple-to-use solutions to the problems connected with campus people working together.

See examples 9 and 10 (ATHENA and NESTOR projects).

VAX Notes conferencing

Todate over 8,000 separate VAX Notes conferences are in progress on DIGITAL's worldwide Easynet system. No matter what special interest an employee may have, this interest is almost certain to have a networked conference already in progress; if not, it is a simple matter to create a new conference. Typically, a conference will be established to help a new initiative get started. Everyone who is likely to be interested in the conference is invited to 'sign-on' and begin participating. In time, others find out and join in on their own. Some conferences have attracted many hundreds of participants and have many thousands of entries and replies stored in them. Users are not obliged to input new ideas and browsing through a conference to read what others have said is quite a common activity.

See example 11 (Post-broadcast communication).

Application simulations

DIGITAL has a growing need to train users in using its software applications. Common to all applications are user interface screens which handle user interactions. It is mostly in the correct use of these screens at which most of the training is directed. The SOLO system provides an exact simulation of the application user interface while supplying voice direction from a low-cost synchronized audio cassette. The combination of these two elements results in a very effective solution for application training.

The speed of authoring the audio and simulation components is such that a 'just-in-time' production philosophy can be applied when bundling the SOLO training resource into the application.

See example 12 (SOLO voice-assisted application simulator).

Videoconferencing DVN and PACE

Corporate interactive learning centres now support video conferencing and DIGITAL Video Network (DVN) which allows large numbers of widely dispersed participants to interact with expert panelists. This medium, if coupled with network activity (E-mail and VAX Notes), provides effective avenues for further enrichment after the video event.

To be successful, high-tech companies must have fast, easy and cost-top effective access to the best available sources of expertise, wherever they can be found: leading European manufacturing companies have recently implemented phase I of PACE- Programme for Advanced Continuing Education; this is clearly a specialised form of distance learning, emphasisng a real-time video component. Through this service, a very important facet of corporate training needs are being catered for. Expertise from European centres of excellence, including major technical universities, is made available through satellite communication at the workplace so that staff incur minimal absence, work disruption and travel costs.

See examples 13 , 14, 15 and 16 (DVN programme and PACE).

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ADMINISTRATIVE USES OF MICROCOMPUTERS

C. Crawford

ABSTRACT

School administrators are discovering a multitude of uses for the latest from the computer age - the microcomputer. Initially used for instructional purposes, many schools and small school districts are now using microcomputers as their data processing center. Administrative functions for which satisfactory software exists include athletics, attendence accounting, budgeting, financial accounting, food service, grade analysis and reporting, guidance, information data banks, instructional management, inventory and property records, media center, planning, scheduling, staff/personnel records, student records, student transportation, and word processing.

Identifying the software most preferred by school administrators to perform these tasks is a project which I began in 1982. A lengthy list of such software exists based on workshop, seminars, surveys, and articles for the American Association of School Administrators, the National Association of Secondary School Principals, the National Association of Elementary School Principals, and the Florida Department of Education.

Florida Department of Education

STATE OF THE ART EDUCATION THROUGH INTERACTIVE MEDIA

Orbry D. Holden *

ABSTRACT

A crisis in public education, particularly in mathematics, science, and technology, has been documented by numerous studies during the last decade. Studies point to a significant decline in the number of people prepared to teach science, the inconsistent quality of science education, the low number of students enrolling in advanced science classes, and the generally low achievement of minority and female students in science. Furthermore, high school graduates are not prepared to work with advanced technology required in business and industry. The purpose of this study is to determine if curriculum delivered via interactive videodisc is more effective and efficient than traditional delivery methods.

INTRODUCTION

Organization of Course

TLTG's physical science curriculum is a 160-hour, two-semester, comprehensive physical science course that illustrates the same concepts presented in traditional yearlong physical science courses. The courseware consists of 15 instructional units including one introductory unit, seven chemistry units, six physics units, and one unit on energy resources that can be taught at the end of either the chemistry or the physics semester.

Instructional Delivery

Students in the curriculum learn through several methods — traditional science labs, teacher demonstrations, written assignments, and innovative videodisc-based instruction. Two types of videodisc-based instruction are teacher-led instruction, involving the entire class, and small group practice activities, allowing three or four students to work together.

OUTLINE OF STUDY AND METHODS

An investigation of student learning with the IVD system and of teacher perceptions of the program was conducted by the Educational Productivity Council at the University of Texas at Austin. Twelve school districts piloted seven units. Two configurations of the interactive videodisc-based delivery of the physical science course were used. Research focused on student achievement and interest in science and on teacher perceptions of the program.

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1. Do students learn more using the courseware than they do from traditional classroom instruction?

2. Does the amount of learning differ for students with different levels of verbal and quantitative aptitude?

3. Does the amount of learning differ between each of the two system configurations (Teacher Only or Teacher-Group) and the control students when aptitude levels are taken into account?

4. Do students using the IVD courseware acquire more positive attitudes toward science and the study and the study of science than control students?

5. What are the teacher's perceptions of the TLTG program?

Methodology

Data collection. Data upon which the evaluation is based were collected over a two-year period: September 1986-May 1987 (pre-pilot phase) and September 1987- August 1988 (pilot phase). Teachers used IVD courseware for one semester only. It should be noted that results reflected in this report are based on one semester of exposure rather than the complete, two-semester course.

Twenty-six teachers and 2,560 students in 12 school districts participated in the IVD pilot study. Student records containing all necessary information for analysis totalled 2,297 (IVD pilot) and 338 (pre-pilot). The number of non-IVD students in the pilot was approximately the same as the number of IVD students.

Class rosters, demographic information (grade level, sex, and ethnicity), and attitude, aptitude, and achievement scores were collected. During the pilot phase, teachers administered achievement and aptitude tests during the fall semester.

Students' attitudes, gauged by their intention to enroll in elective science classes, were also measured. In May 1988, representative subset of students from IVD and non-IVD classes in five school districts answered the questionnaire.

RESULTS

Research Findings

1. IVD students generally outperformed non-IVD students on all ability levels in both verbal and quantitative categories.

2. 1988 IVD students outperformed 1987 non-IVD students under the same teacher in four categories: low-verbal, medium quantitative, high verbal, and high quantitative.

3. The Teacher Only Configuration produced advantages for all categories except low-quantitative. The differences were

moderately great for all categories except the high-quantitative, which was only slightly higher.

4. Low-verbal, low-quantitative, medium verbal and high- quantitative students in the Teacher Group Configuration performed better than non-IVD students. Medium-quantitative and high-verbal students performed slightly better in the non-IVD class.

5. IVD students showed a positive intention to take more science courses than non-IVD students. This intention was even stronger for those students who had not previously failed math or science in school.

6. IVD students showed a more positive attitude toward the study of science than non-IVD students.

Findings on Courseware Use

1. Teachers used a variety of instructional delivery methods in a single class period. Examples are demonstrations, lectures, a video sequence, and practice sets or video practice.

2. During a 20-30 minute electronic instructional sequence, 75% - 100% of the students paid attention to the video.

3. Teacher control and student motivation is a major factor in the number of students attending to the IVD system.

4. Generally, students in video-based small group activities were highly involved and engaged in a large amount of peer tutoring.

5. The most effective group size for electronic activities was three to four students.

6. Teacher used a variety of grouping strategies.

Teacher Perceptions of the TLTG Program

1. Teachers like teaching using the TLTG program.

2. Teachers who experienced an increase in student attention from the previous years, noticed a reduction in discipline problems.

3. Some teachers experienced increased control over their classes because the program helped them to organize and structure the instructional materials.

4. Teachers maintained that students not only learned more with the TLTG program but also like the course more than students who learned with traditional methods.

EDUCATION AND BUSINESS SHARE TECHNOLOGY BUT, DO THEY SHARE THE COMMITMENT TO USE IT EFFECTIVELY?

Daniel E. Barbrow

A corporation is destined for failure if it does not meet the needs of its customers and shareholders. That is why fifty percent of all new businesses cease within the first two years of operation. This is also why companies allocate considerable time, effort and funding to develop operational strategies. Such plans are not unusual; they are expected. In many cities, the local school district competes with business in such realms as: budget, payroll, plant facilities and the acquiring of technology. Too often, however, these resources are not used in a manner that is the most productive.

More than ninety percent of American schools have acquired computers and VCR's. Many are purchasing modems, networks and FAX machines. Elements of mechanical and electrical technology are very common to education, but how it is being used is becoming an important concern. According to a National Association of School Boards survey, eighty-five percent of the computer acquisitions in schools were done without any formal research or planning. As education is held more accountable for its product and operation, such practice must change.

The following outlines some of the major considerations necessary for planning and implementing for the use of technology at a local school district level.

CHOICE OF THE PLANNING TEAM
  -Who will be affected by the project?
  -Who will ultimately take ownership?
NEEDS ASSESSMENT
  -What is needed?
  -What is wanted?
RESEARCH
  -What sources of information are available?
  -What information is needed?
GOALS AND OBJECTIVES
  -What are the general goals of the project?
  -What specific objectives will be met in reaching those goals?
  -Who is responsible for seeing that specific objectives are met?
BUDGET
  -What funds are necessary to meet the goals?
  -What are possible funding sources?

TIME LINE

- How long will it take to implement the project?
- What must be accomplished at specific time intervals?

COMMUNICATION

- Who needs to be updated?
- What information is going to be of most value to them?

EVALUATION

- Who is responsible for evaluation?
- How effectively have the goals been met?
- What must be done to improve performance?

Many of the above considerations do not directly involve decisions about hardware or software. This is because a primary focus of educational technology should not be just what to buy, but how to use the equipment most productively. Computers, interactive video and such will never meet the needs of education if they are merely considered to be "add-ons" to the existing curriculum. The use of technology should be a means of helping students better understand math concepts or exploring scientific possibilities. Technology should not be a reason for asking for more teacher generated lesson plans.

If computers and other forms of technology are to be successfully implemented into curriculum areas, educators must change current practices and philosophies. That will not be easy because education is a very status-quo institution. Innovation often occurs only when there is an overwhelming necessity. Many feel the necessity to change is here. The population is looking for a better educational product and the economic sector is warning that the product must be produced in a more cost effective manner. Educational technology can be an effective tool in meeting that challenge. Successful schools will follow the same principles as successful businesses. The strategy will be to develop a proper plan to meet the need and commit to the action necessary for accomplishing the task.

TECHNOLOGY FOR ALL

S E Davis

ABSTRACT

Gone are the days when the "Computer Center" lurked somewhere in the corner of the building, access forbidden to all save those few eccentric technical types. No longer need the capabilities of data processing be controlled by a select few and doled out to the remaining staff like merit badges. Today's technology is designed for the general population of any organization. Companies are now aware of the value of producing "user friendly" software. Database is the technology of the future based on the concept that information needs to be available in any form, at any time, to anybody. The "Distributive Processing Approach" allows us to provide for the individual needs of the various geographical locations within a school district and through communications maintain the ability to provide cumulative data control. If then, the technology in fact exists to achieve the things mentioned above, why is it not being more freely put into practice. The answer to that question may lie in the "logistics of implementation".

The purpose of this paper will be to deal with the concepts and consideration in implementing a distributive processing system within the district. The system currently installed at the Grapevine Colleyville Independent School District includes an in-house mid-range system located at the Administration Building which communicates with both the mainframe located at the Regional Service Center, and four smaller mid-range systems (IBM 5363's) located at the High School and Middle Schools for administrative requirements; as well as, the capability to connect to the CAI labs located in these schools to gather student progress information. Software applications currently provided by the in-house system, in addition to the normal student services and accounting packages which are provided in an RJE environment from the Region, include food services, fixed asset accounting, multi-entity tax administration and collection, word processing, district wide electronic mail, and various database applications.

As the actual hardware and software consideration are only a small part of the implementation, emphasis will be placed a great deal on developing a technology plan, dealing with internal politics, identifying responsibility, staffing considerations, the need for a training program, as well as the basic hardware, software, and communications considerations. Examples, documentation and slides will be used from the system currently operational at GCISD.

Grapevine-Colleyville I.S.D

COUNSELING AND COMPUTING: COMPATIBILITY?

L. O. Ascher.

ABSTRACT

Counselors have come to recognize their need for computer technology. Resistance remains to actually integrating them into the guidance office. Many concerns about the technology are based on personality traits. Counselors are generally a social personality type whose strengths and preferences lean toward using perceptive and verbal skills rather than mathematical and analytical that they perceive that the computer environment requires. The individual needs to see meaning in the new skill or knowledge and feel comfortable and capable with this new tool. Computer applications for counseling, documentation and registrar functions are readily available. Training must be oriented to the identified needs, perceptions and personality type of the counselor.

PAPER

> One-third of the items on supermarket shelves today did not exist 10 years ago; 50% of the labor force earns its living in industries that did not exist when this country was founded; 75% of all the people employed by industry 12 years from now will be producing items that have not yet been conceived of. (ref 1)

Harold G. Shane (ref 2) reports that knowledge is projected to double every 24 months by 1990. The counselor serves a critical role in preparing people to live in this ever accelerating society. The limits of human cognitive processing require new resources to analyze and sort this plethora of ever-expanding data. The computer offers an extension to human intelligence. It does well those things that humans tend to do poorly: retention, retrieval and processing of data. Its ability to handle information quickly and efficiently enhances the counselor's performance. Effective helping relationships demand this quick access to information.

Counselors have come to recognize their need for computer technology. Blum and Kishner surveyed counselors in five Utah school districts (ref 3) to develop a plan for implementing computer-assisted guidance and counseling. Blum and Kishner found that 88.5 percent of the counselors were interested in learning more about the computer, 81.7 percent felt that computers should be used in computer-managed counseling and 88 percent felt that computers should be used for computer-assisted counseling. These counselors indicated four general areas of concern: how computers could be best used in counseling, how the computer might change their role as a counselor, how the reorganization to accommodate the computer would affect their professional status, and what time and energy commitment would be required to use the technology.

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Although most counselors seem to accept the need for using computers, resistance remains to actually integrating them into the guidance office. One difficulty is the perception of the technical knowledge required to use effectively this new technology. Counselors should be invited to see the computer as a tool for cognitive processes such as remembering and comparing. This is analogous to the automobile as a tool for locomotion processes such as running and walking. Even though the automobile has the potential for abuse, the overall benefit to humankind has been enormous. One doesn't need to understand the inner workings of the automobile in order to drive, nor must one understand the inner workings of the mother board in order to take full advantage of the resources the computer has to offer.

The axiom that many counselors apply to their clients must be applied to them: you must begin where the client is. Not only does the individual needs to see meaning in the new skill or knowledge, but he/she needs to feel comfortable and capable with this new tool. An understanding of the needs, concerns and perceptual frame of the learners is required to be able to create an inviting environment.

Counselor concerns about the technology are based on personality type. John L. Holland's (ref 4 & 5) model of career choice characterized people and work environments and found that agreement of the type and environment correlated positively with career satisfaction, stability and achievement. Counselors are generally a social personality type whose strengths and preferences lean toward using perceptive and verbal skills rather than mathematical and analytical that computer environment requires. The negative stereotypical perceptions of counselors of both computer environments and people who operate computers prejudice the counselor against facile integration. In training guidance personnel, one goal must be to ensure that realistic perceptions about computers and computer operators are developed.

Appropriate uses for the computer in in the guidance office is a question oft debated. Little research in this area has produced inconsistent results. The professional associations The American Association for Counseling and Development (AACD) and American School Counselor Association (ASCA) have recognized the need to address the question and have begun to explore this issue. Both associations have published numerous articles discussing computers and counseling, but at this time neither association has set any guidelines other than that any uses of the computer in counseling should comply with professional ethical standards.

The use of the computer to assist in the management of the guidance office, Computer Managed Counseling (CMC), is one of the most widely accepted uses of technology. The tools for this are already in wide use: word processing programs, data base programs and spreadsheet programs. Currently available integrated packages offer excellent choices for use in the guidance office. Confidentiality of the data is a major concern in the counseling field because of the sensitivity of information involved. Counselors with limited understanding of the technology become alarmed when they read of "secure" systems being compromised by hackers. Counselors using microcomputer systems can be reassured by demonstrating that data can be stored entirely on a removable disk that is then physically secured by the counselor. This method returns the responsibility of confidentiality to the counselor and enables him/her to protect a client's trust in a way with which they are comfortable.

Counselors know the importance of communication. Mail-merge techniques can be used to personalize messages to parents, teachers and students. The use of word processor templates can make the job of communicating much more efficient and more personal. The introduction of these techniques to counselors should come after evaluating what type of communications they are already using. By creating templates of letters and forms that are already in use and demonstrating how much more personalized and efficiently they can be produced with the computer, the trainer can show immediate benefits to the paper-logged counselor.

A more difficult issue is how will technology affect counseling roles and the status of the profession. While it is accepted that the computer is a tool that can make counselors more efficient in this record keeping and paperwork, counselors fear that the ability to do more will encourage administrators to expand the counselor's recordkeeping duties. Most school guidance departments serve three general functions: counseling duties (career, academic and personal/social), documentation duties (exceptional education or other special programs) and registrar duties (scheduling and record keeping). CMC primarily impacts the later two functions, an area where many counselors already feel they have too much involvement. To accept CMC as a nonthreatening addition to their office resources, counselors must perceive a clear administrative commitment to continue counseling duties.

Computer Assisted Counseling (CAC) programs are also available for each of the three roles comprising counseling duties, the area with which most counselors are concerned. Career guidance applications take two general approaches. The first approach involves evaluation of student interest and/or aptitude and the recommendation of some class of occupations that correlate with that student's evaluation. These generally involve some form of test measuring student interests, abilities and/or values which then is correlated to occupations or a class of occupations. Some of these systems combine the first and second approach in one application. The second is an information system, primarily databases, offering information about occupations to the student. Both types of systems are widely available and used in school settings.

CAC applications for academic counseling are also commonly available, and include computer software developed for instruction. Academic counseling software offerings include academic remediation through tutorials and/or drill and practice simulation, academic games, study skills and test taking skills. Counselors need to be familiar with each of the specific programs and should use them in a prescriptive manner. These programs can be useful when they address an academic deficiency.

CAC systems for personal/social counseling are not widely available. The speed that the computer handles large amounts of information when combined with clever algorithms can give the impression of genuine understanding. However, care should be taken to not equate the machines apparent intelligence with thought, creativity or understanding.

A glimpse of the potential for confusion between what the computer can do and what counseling is can be seen in reactions to the ELIZA program which Joseph Weizenbaum wrote in the mid 1960's. ELIZA modeled Rogerian therapeutic technique. The program has no understanding, but parses the input, matches key words and phrases and composes a response. Even users who were familiar with the program's algorithm were drawn into the conversation with ELIZA and developed something like a therapeutic relationship. Weizenbaum was so alarmed by the reaction that he wrote Computer Power and Human Reason, a book distinguishing the tasks that can be offered by humans and by computers. All computer assisted guidance systems should be used after a counselor has evaluated the client's needs, identified appropriate software and implemented a plan for constant evaluation and follow-up.

Because computer programs are attractive and nonthreatening to students, they can serve the counselor well in reaching counseling goals. Game-like simulations allow students to experiment with behaviors that could be threatening or dangerous. Experimentation and exploration are important to the counseling process, but it is essential that the exploration be followed up with cognitive processing. Other computer games can serve to create an invitational atmosphere in the guidance office. Those same games may also serve as a metaphor for the real world in the counseling setting. Paint or graphic programs may be used rather than paper and pencil with art therapy techniques. Spreadsheets and graphs can be used to help students record changes that they make. Re-purposing applications and using them within the counseling setting is limited only be the comfort and creativity of the counselor. However it should be emphasized that the counseling process is the focus and the computer only a tool.

Sufficient inservice time when school is not is session must be provided for counselors to learn to use the computer and software. Counselors, by the very nature of their roles, do not and should not have sufficient time while students are in school to invest in learning computer systems. This training must be oriented to the identified needs and perceptions of the counselor. Only after the counselor becomes comfortable with the computer as a tool will the counselor be prepared to offer guidance programs equipped to prepare our children for the future.

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PLANNING: POWER FOR THE DEVELOPMENT OF A COMPUTER LAB

W.L.Kertzman*

ABSTRACT

A good organizational plan is a positive and necessary factor in the successful acquisition of computing equipment for public schools. Personal experience in the development of computer labs at the middle and high school levels is drawn upon to provide information intended to be helpful in the presenting of requests for hardware and software. Topics to be covered include a rationale for such expenditures; a discussion of methods for counteracting negative attitudes about a project; organizational needs and suggested sequence; and various steps in the implementation process, including physical design, funding options, faculty training, student involvement, and equipment installation.

INTRODUCTION

Though we would have hoped for more progressive attitudes by this time, many schools still do not have adequate equipment for use by computer programming and literacy classes or by the classroom teacher of other disciplines who wishes to use computers to supplement the regular curriculum. Because this is a disservice for our students, we must be able to present reasons and methods for using our resources, both time and money, to provide the necessary technological tools that will aid in the development of computing skills needed by young people in the present and in their futures.

The following organization and ideas are the result of participation in the design of both programs and facilities for computer labs located in magnet middle and high schools in an urban district of approximately 45,000 students.

OVERVIEW

A lack of computing equipment and materials in a school may be caused by a combination of factors, and each should be carefully analyzed before attempting to address their solution. Often, a shortage of funds is the main problem; occasionally, however, a lack of vision, organization, or even personal biases are at fault. There are ways to improve upon, and sometimes eliminate, any of these negative influences. Funding can be obtained, even in difficult times. People can be shown how to think positively in order to complete a demanding task. Organizational skills can be learned; and through careful design, projects will be successfully realized in concrete form.

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PROCESS

Assuming that someone has declared a need for computers, our apparent goal seems to be how to obtain the equipment. Usually, this is not so simple that a mere telephone call will accomplish the task. The successful undertaking of an expensive project, perhaps one intended to create a new discipline, often requires the cooperative efforts of many persons. A well-organized plan might mean the difference between failure and achievement, and the steps listed briefly below can be used to create one more tool to effect the desired results.

It is a given that the first step in solving a problem is to understand that same problem. Though this may sound like an oversimplification, it is essential that a clear focus be established as to **why** computers are needed by a school. This should be a participatory process involving input from as many groups as possible, including faculty, administration, community patrons, and the student body. District goals and building objectives must be considered and developed, but throughout the process, it is hoped that the needs of the young people themselves will be the main catalyst for the decisions being made.

Educational publications have well documented the experience of many schools as they discovered the fallacy of insufficient research before requesting specific hardware and software. Thus, at this point it might be emphasized that enough time should be allowed to make informed and sound decisions, since you will live with the consequences of any purchase for a very long time. Everyone must be made to understand the importance of avoiding hastily-drawn conclusions and the purchase of inappropriate items. Despite this apparent slowdown, a simultaneous enthusiasm must be maintained for the project: a push-and-pull situation!

Once the needs of a school or department have been clearly stated and justified, and informed persons are available for decision-making, a scope and sequence chart of desired skills (and their relative rate of introduction and reinforcement) should be developed. Then, using this plan as a guide, appropriate software can be selected. This, in turn, will determine the hardware needs for the project. Installation sites should be chosen and building modifications need to be considered. Even a single computer system requires consideration of a table, seating, software and documentation storage, and electrical connections at the minimum.

When a list of all necessary components has been made, an estimate of cost can be calculated. Your district may use a central purchasing method and provide you with discounted school prices for many of the purchases and services involved. On the other hand, you may need to seek suppliers on your own. Even in the case of a central purchasing policy, you may be able to stretch your dollar further if you can provide the name of reliable vendors who are less expensive than those on a district list.

Once an estimated cost for the project is known, list all possible sources of revenue for the equipment, software, and supplies. Also record any perceived hindrances, and analyze the causes of the problem. Begin noting any reasonable method of eliminating the difficulties, and again use input from as many persons as seems feasible. Match income to expenses, funding source to possible expenditure, and determine the shortfall for the overall project. A decision must then be made as to whether it is preferable to establish a 'sinking fund' and delay any purchases until the entire project can be funded, or whether to attack it piecemeal as monies become available. A third approach is to combine purchases with donations and other creative funding methods.

One strategy often used or required in the funding process is the writing of a formal proposal to substantiate a need for and intended use of the computing equipment. The results of all the previous steps can be incorporated into this proposal, creating a well-supported and professional document. The proposal might be a succinct but well-stated summary of all the preparatory steps and supporting information, or it can be a lengthy compendium of: rationale (including technological explosion, public support, world competition, academic development, individual needs assessment and reinforcement, and opportunity for the school in question); objectives; funding suggestions; planned applications; intended implementation methods; and projected benefits for the students. This can be accompanied by evidence of the planning and preparation that preceded the submission of the proposal, description of successful (and related) programs in other schools, and even a few well-selected articles to support your viewpoint and inform or excite the intended reader as he learns what this project can do for your school and district!

Often, a strong emphasis must be placed on the need to justify the importance of computer education to persons who may have more power, money, and responsibility than they have computing experience. Methods of information and persuasion, as well as specific arguments, must be prepared for use by teachers who will find themselves playing the role of general (possibly gentle) persuader.

Eventually, the project should see fruition, and implementation will begin. This includes everything from unpacking, creating an inventory, setting up, teacher training (if needed), preparation of support materials and lessons, organizing storage, making backup copies of software, perhaps scheduling the use of equipment, and preparation of handouts such as instructions, lists of available software, and those ubiquitous schedules. If equipment is to occasionally leave the building for use by faculty or students, a checkout procedure must be devised. Thank you letters are an investment in good will, and an open house might even be planned.

Concurrent with the steps discussed above, it will have been important to the success of the project that the support and interest of both building and district personnel was cultivated. This is a step which requires patience and diplomacy, both of which may be in short supply as the pressures and responsibilities of the project multiply. All things can be made more pleasant and less demanding if, as suggested earlier, a very reasonable time line was decided upon for the completion of each step, and if input for the project has come from many people, several of whom will probably be willing to help with the myriad mundane details which accompany even an important project. Many shoulders make the load light.

CONCLUSION

In this time of emphasis on educational deficiencies, it is contended that we must continue to educate our school patrons, school boards, and community businesses to the fact that computer education is as much a basic need as reading and mathematics. Only with that amount of support can we hope to be successful in acquiring the tools needed to meet this need and to prepare young men and women for the next few decades of their lives. The key to such success, however, lies in planning. Planning that gives us the power to overcome the many obstacles which lie in the paths of all good projects, and which enables us to create more learning opportunities for our students.

INFLUENCE OF GRADUATE EDUCATION ON EDUCATION POLICY DEVELOPMENT OF ADMINISTRATIVE AND INSTRUCTIONAL COMPUTING PRIORITIES

Brent Edward Wholeben†

ABSTRACT

A study of N=853 professional educators from a three-state (USA) region posited that (a) existence of graduate education (compared with baccalaureate only) and (b) extent of graduate training (measured in semester hours) are significant indicators of future priorities for specific subsets of 52 identified policy objective priorities in educational computing. Respondents identified their top-20 priorities for policy objectives from an initial list of 52 objectives, then selected a list of top-10 priorities from the secondary list of 20 objectives. The existence of graduate-level education was significantly ($p < .05$) related to top-20 issues concerning access privileges, hardware and software resources, and the rights of students in various instructional settings. When selection was constrained, from top-20 to top-10, policy development priorities were redirected to areas concerning organization (school unit), privacy assurance, and teacher rights. Only one of the initial top-20 priorities remained significantly important to respondents after the top-10 conversion.

INTRODUCTION

The International Council for Computers in Education released in 1987 the Code of Ethical Conduct for Computer-Using Educators, a comprehensive statement on ethics and equity in educational computing comprising 52 separate guidelines related to curriculum, access, privacy and confidentiality, teacher, student, community, organization, software, and hardware. Would these guidelines be accepted by the education profession? Which issues would be considered sine qua non requirements? Which statements might be relatively unstable during periods of constraint? What differences might be contrasted between educators who had some level of graduate education experience and those who did not?

This paper presents the results from an initial stratified random survey of K-12 professional educators (n=853). The data collection instrument was self-disclosing by respondent. First, to establish an initial priority ordering, each respondent selected 20 of the available 52 statements as perceived requirements for a comprehensive policy on computing ethics and equity. Second, to simulate an artificial environment of imposed general (viz. undefined) constraints, each respondent selected the top-10 of these initial 20 components.

ANALYSIS

Analysis of variance was performed, utilizing the number of total semester hours of graduate education accumulated (dependent variable) and

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whether the respondent established either a top-20 or top-10 priority for each of the policy objectives under study (independent variable).

FINDINGS

Greater accumulated semester-hours were significantly ($p \leq .05$) related to privacy issues in both administrative and instructional computing when top-20 priorities were identified. Similarly, less semester-hour training was related predominately to hardware resources and teacher rights. When selection was constrained from top-20 to top-10, respondents with greater accumulated hours of graduate training diversified their priorities to issues related to community and organizational needs. Subjects with less accumulated hours retained support for hardware issues while directing new support for policy priorities in the area of teacher rights. (Refer to Table 1.)

DISCUSSION

Unconstrained Policy Development

Four (4) unconstrained priorities were found to be related to lower accumulations of semester hours in formal graduate education coursework:

01 Help students learn about future trends, possible impacts and consequences of a computerized society.

02 Respect the efforts and expertise of hardware developers and vendors, particularly when they risk extending the uses of the computer.

03 Allow for cooperative participation of teachers and administration in the selection of equipment.

04 Develop and communicate criteria for hardware used in education.

Similarly, two (2) priorities were found, when policy priority selection was unconstrained, to be related to higher accumulations of semester hours in formal graduate education coursework:

01 Review the use of computer systems and networks to ensure appropriate confidentiality and privacy for all.

02 Ensure that access to data bases does not exceed the limitations of use understood at the time the data were provided.

Constrained Policy Development

Five (5) constrained priorities were found to be related to lower accumulations of semester hours in formal graduate education coursework:

01 Strive to provide teachers with released time for computer training to a level of competency consistent with their projected use of computers.

02 Strive to provide opportunities for teachers to learn about future trends, possible impacts and consequences of a computerized society.

03 Strive for computer literacy by both teachers and students.

04 Allow for cooperative participation of teachers and administration in the selection of equipment.

05 Develop and communicate criteria for hardware used in education.

Lastly, three (3) priorities were found, when policy priority selection was constrained, to be related to higher accumulations of semester hours in formal graduate education coursework:

01 Review the use of computer systems and networks to ensure appropriate confidentiality and privacy for all.

02 Provide training to members of the educational or general community when asked and when practical in order to encourage parental involvement in long-term planning of computer use.

03 Participate in short- and long-range plans to introduce and manage hardware and software in schools.

RELATED FINDINGS

Source of graduate discipline was examined across 10 distinct academic units which were degree-granting. Significant ($\underline{p} \leq .05$) differences were found between disciplines in the top-20 areas of curriculum, hardware and software resources, privacy rights, and teacher needs. When priority selection was constrained, significant differences were shifted to issues related to student access and instructional protocols. Priority policy objectives were retained in only three instances, related to hardware, privacy, and teacher rights. The collegial sources of these differences, and their discriminative interpretations, are the subject of a parallel study whose results will be released in mid-1989.

Table 1. Summary of unconstrained and constrained policy priorities in terms of differential levels of graduate education experience.

Unconstrained Policy Development

Priorities related to lower completed hours of graduate education

- LRNG OPPORT RE COMPU SOC TRNDS (strategic vocational instruction)
- RSPCT VENDOR EXPRMT COMPU USES (vendor initiative acceptance)
- TCH/ADM PARTIC IN EQUIP SELECT (participatory selection)
- DEVL/COM CRIT RE EDUC H/W USES (criterion development)

Priorities related to higher completed hours of graduate education

- INSUR COMPU SYST CONFID/PRIVCY (summative security assessment)
- LIM DB ACCSS BY INIT GATH GUID (formative accountability assessment)

Constrained Policy Development

Priorities related to lower completed hours of graduate education

- TM RELEAS FOR TRNG RE PROJ USE (release time for training)
- LRNG OPPORT RE COMPU SOC TRNDS (extra-education literacy)
- COMPU LITRCY FOR TCHR AND STUD (comprehensive user literacy)
- RSPCT VENDOR EXPRMT COMPU USES (vendor initiative acceptance)
- ACKN ETHIC OF QUAL H/W VENDORS (vendor validation)

Priorities related to higher completed hours of graduate education

- INSUR COMPU SYST CONFID/PRIVCY (summative security assessment)
- PRNT INVL IN COMP STRATEG PLNG (participatory planning)
- PARTIC IN TAC/STRAT COMPU PLNG (inter-agency strategic planning)

BITNET: AN INTER-UNIVERSITY NETWORK

T.J. Pettibone*

POSTER SESSION ABSTRACT

BitNet is an inter-university network of computer centers. There are over 2000 computers at over 700 institutions of higher education and research centers. There are European members, Canadian members, and Far East members, as well as members in the U.S. (See attached maps).

BitNet stands for "Because It's Time" Network. The network allows for the sharing of information via electronic mail, document forwarding, programs, and data. Member institutions support BitNet through their normal local electronic mail systems. There is no extra cost associated with using BitNet. If you have access to a mainframe computer at any of the 700 member institutions then you can use BitNet. Generally, free access to BitNet is afforded to faculty, staff, and students at member institutions.

This network is known as a "store and forward" network. While there can be some "real time" sharing, most traffic flows in a node-to-node manner taking from a very few moments to several minutes. If there are any intermediate nodes "down" then there can be delays in delivery. Typically, though, "traffic" is delivered relatively quickly, and at no extra cost. Transferring documents at baud rates of up to 9600 speeds things up considerably compared to the "normal" rate of 300 or 1200 baud. Leased lines between institutional nodes are used in these transmissions.

Many different types of computers are supported on the network including IBM, DEC (including VAX), CDC, and Sperry. BitNet also can connect with other networks including: ARPANET (Defense Advanced Research Projects Agency); CSNET (a network of computer science departments); MAILNET; and UUCP, a UNIX-based dial-up network with over 1500 nodes world wide. Other network accesses are being worked on currently.

BitNet is supported by EDUCOM and the City University of New York. Extensive on-line documentation is maintained to help the user effectively and efficiently access the network. Much of the funding of BitNet has been provided by IBM.

BitNet also allows the user to hunt for users with similar research or teaching interests. This requires that users "tell" the system their interest. Once done they can search for "long distance colleagues" using BitNet.

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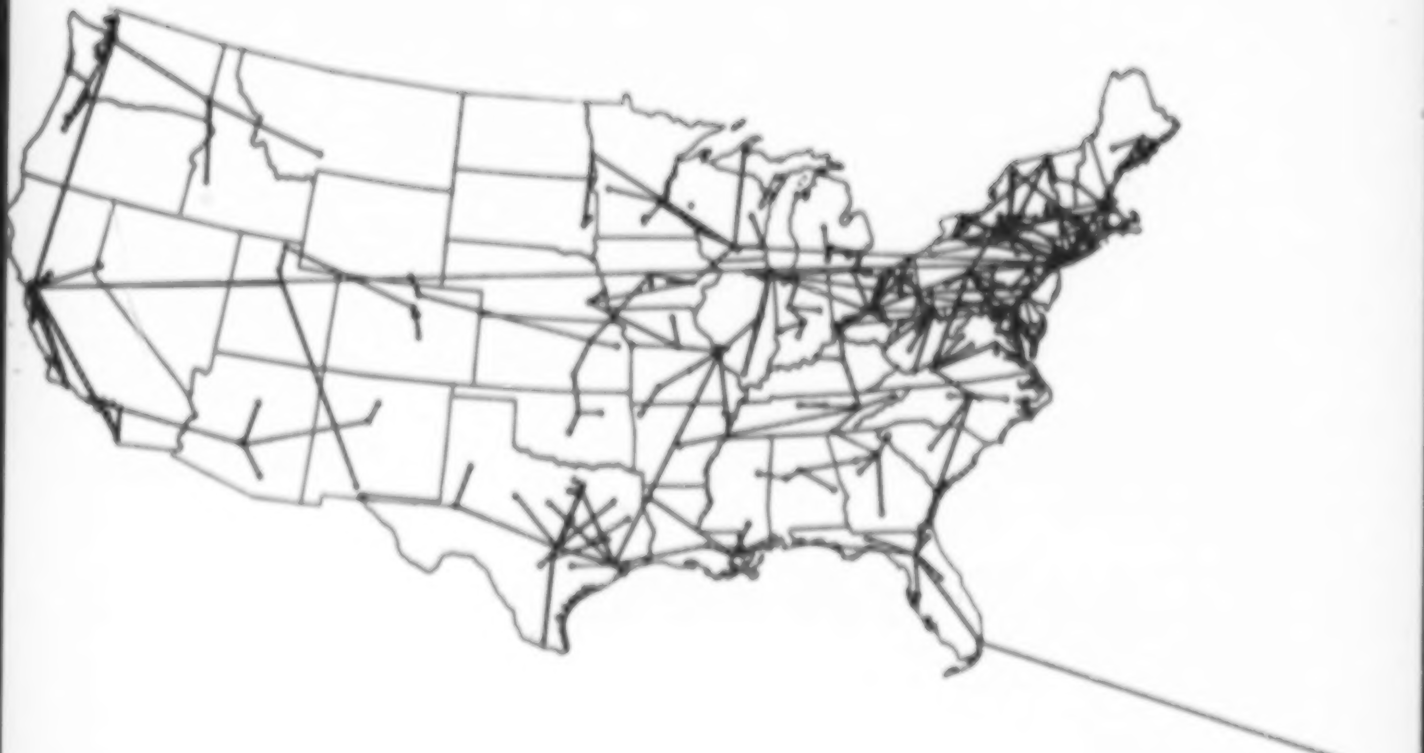
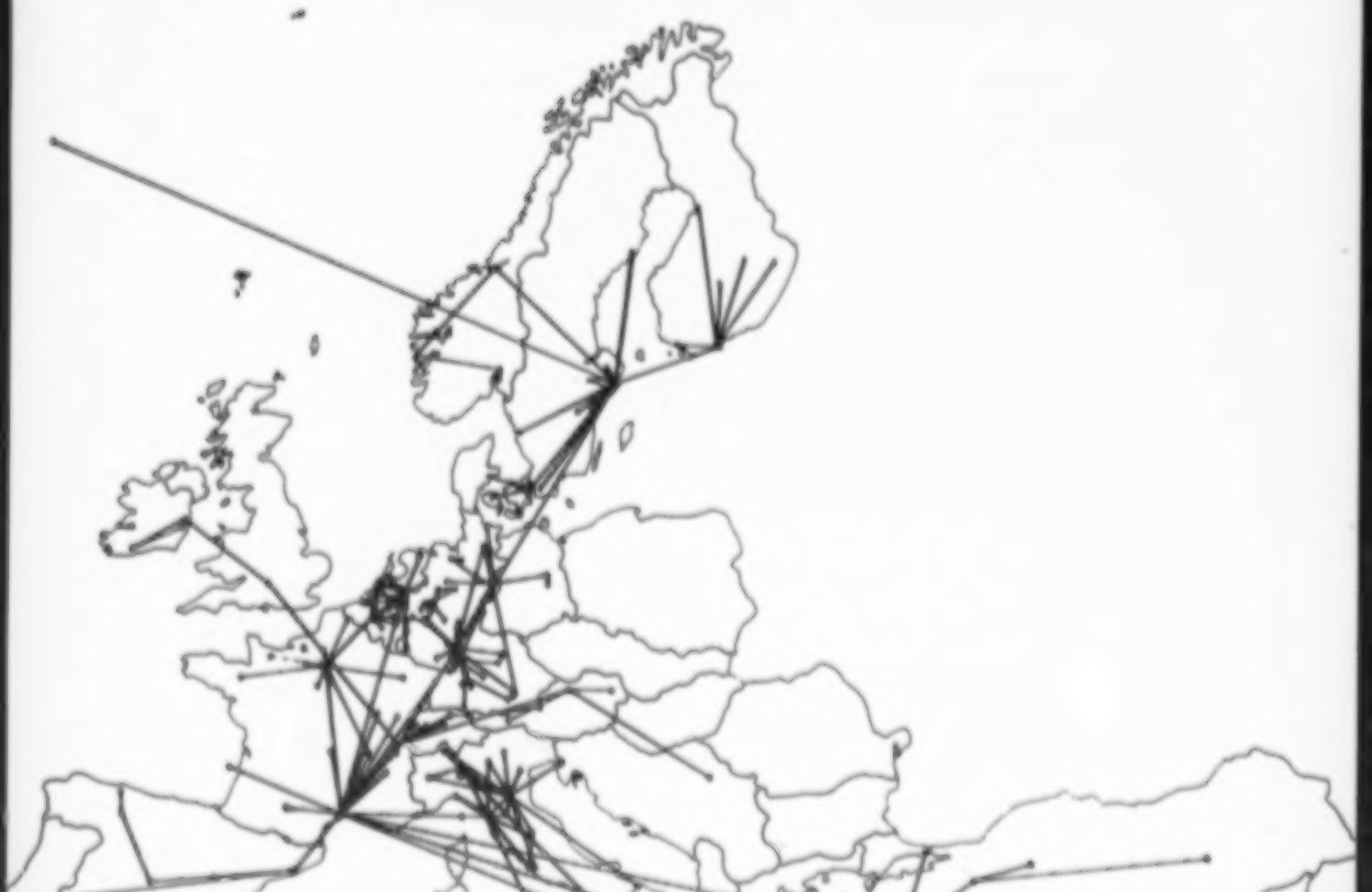
BITNET TOPOLOGY

AS OF AUGUST 1988



EARNET TOPOLOGY

AS OF AUGUST 1988



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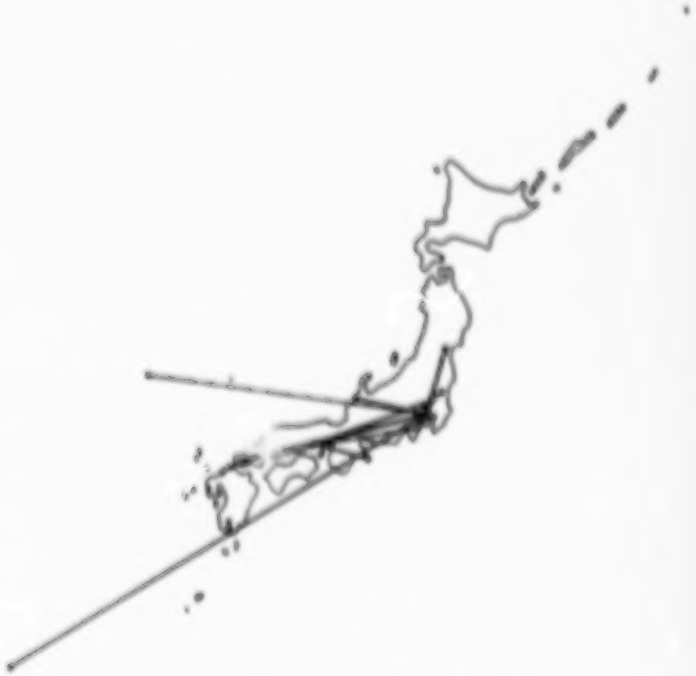

THE MATURITY FACTOR IN SUCCESSFUL ELEMENTARY SCHOOL INSTRUCTIONAL COMPUTING PROGRAMS

Dr. John F. Beaver*

ABSTRACT

In the fall of 1987, a study was conducted which examined specific elements of high quality elementary school instructional computing programs. The results detail the approaches adopted by school leaders in a national sample of elementary school identified for the excellence of their instructional computing programs. The study particulary investigated the effects of program maturity on instructional computing practices. The findings show that programs which have been established for a longer period of time differ from more recently established programs in every element examined. The characteristics investigated include students per computer ratio, various budgetary issues, the amount of staff involvement in computing programs, time periods included in the long-range planning, and the manner in which the computer access time is allocated.

INTRODUCTION

Does the length of time that computers are used instructionally in a school influence important characteristics of that school's instructional computing program? Although traditional widsom holds that deeper understanding accompanies experience, most of today's popular microcomputer applications either did not exist or were not widely available until five or fewer years ago. Recently developed school instructional computing programs have certainly benefitted from the technological advances of the past half decade. But have those programs used the acquired knowledge obtained by the efforts of earlier programs in a meaningful way? A reasonable assumption would posit that the educators in schools which had the most instructional computing experience would use their computers differently and perhaps, more wisely than schools with less instructional computing experience.

However, the leaders of schools with more recently developed computing programs have a greater body of literature concerning educational computing from which to draw and lèarn, providing them with a number of approaches described by research studies. Long established programs may be fixed in their instructional computing practices while more newly developed programs may have more opportunity to avail themselves of advances in either the technology or the methods of using it. Therefore, more recently established programs could reasonabley duplicate or suprass the more established computing programs. The issues called for clarification.

OUTLINE OF THE STUDY

In this study, program maturation was included as an important variable to determine the effects of program longevity on instructional computing practices. A national search identified 73 elementary schools for the high quality of their instructional computing programs. The Office of Technical Assessment (OTA) in Washington, D.C. supplied a list of districts known for their support of instructional technology. Representatives from

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these districts then identified the particular elementary schools in their districts which they believed had developed the most outstanding instructional computer programs.

These schools were then surveyed (with a 70% response rate) using an instrument designed to gather data on selected topics relating to their instructional computing programs. The program comparisons considered the following characteristics: the ratio of students to computers, the total expense on computer-related items, the 1986 comptuer budget, the 1987 computer budget, the presence or absence of computer expenses as permanent line items in the budget, the number of years for which instructional computing plans have accounted, the extent of teaching staff involvement, and the actual and ideal allocation of the available compluter access time. To investigate the issues involving program maturation, the schools in the study were stratified into two groups according to the length of time for which their instructional computing programs have existed. The schools whose programs had existed for 4 or fewer years (the New group) were compared to the schools whose programs had existed for 7 or more years (the Mature group).

FINDINGS

The demographic ratio of interest, students per computer, revealed a substantial difference between the two groups of schools. The Mature group had a mean of 16.6 students per comptuer while the New group has a ratio of 21.5 students per computer. Thus, the study discovered that the Mature schools have nearly 30% more computers available for students than do the New schools.

The four comparisons involving budgetary considerations also revealed substantial differences between the Mature and the New schools. The data verified the anticipated findings concerning budget: the equipment advantages enjoyed by the Mature group implied that they expended more money on the purchase of their equipment. The Mature groups spent 46% more money on the total amount of computer-related items in its buildings than the schools of the New group. In addition, the 1986 budgets of the Mature schools were 22% higher than those of the New group, while the 1987 budgets were 18% higher. All three comparisons are consistent with the equipment ratios previously presented.

The final budgetary comparison concerned the presence or absence of comptuer-related expenses as permanent line items in school budgets. The investigation showed that 58% of the schools in the Mature group include computer expenses as permanent line items in their budgets, compared to less than 7% of the schools in the New group. This finding is consistent with thie results from the other examinations of budgetary factors. For all four budgetary considerations, the characteristics of the Mature schools differ considerably from the characteristics of the schools in the New groups in ways that demonstrate the Mature schools are more the progressive in creating a supportive environment in which successful instruction can thrive.

The next factor examined involved an important element of the planning process guiding the instructional computing program development--that is, the number of years accounted for as part of their planning. In the New group, 53% of the schools planned for only the current year, compared with only 33% of the Mature schools. On average, the Mature schools planned for the next 2.8 years, while the New schools planned for only the next 1.9 years. Again, siginficant differences exist between the two groups of schools: schools in the Mature group plan for a 45% longer period of time.

As important as either planning or budgeting is the extent of the teaching staff involvement in the instructional computing programs. The mean involvement in the instructional computing programs. The mean involvement level in the New schools is 57% of the staff; in the Mature schools, the involvement level is 85% of the staff. In addition, 67% of the Mature schools have achieved total staff involvement, compared to 41% of the New schools, indicating that a much higher level of teaching staff involvement exists in the instructional computing programs of the Mature schools.

Naturally, the way a school allocates computer access time has a clear impact on the overall quality of the program. For that reason, the allocation of the available computer time was the final computing program characteristic examined. The data show that significant differences exist in the way schools in the two groups allocate the computer time devoted to computer applications and comptuer-assisted learning. The mean computer time allocation for the Mature schools is 16% for computer programming, 46% for computer-assisted learning, 35% for computer applications, and 3% for other uses. The mean time allocation for the New schools is 18% for computer programming, 59% for computer-assisted learning, 21% for computer applications, and 2 % for other uses. The Mature schools devote nearly 14% more time to computer applications than the schools in the New group. Clear differences are also apparent in the manner in which instructional leaders in the two groups would ideally like to allocate their computer time. Of the available time, the leaders of the mature groups would devote 9% to programming, 40% to computer-assisted learning, and 51% to computer applications. By comparison, the leaders of the New group would like to allocate their available time according to the following formula: 19% to programming, 46% to computer-assisted learning, and 35% to computer applications. The two groups differed substantially both in the way they actually allocate their computer time and in the way they would ideally like to allocate the computer time. The Mature schools clearly place greater emphasis on using computers with application programs whereas the New schools emphasize comptuer use with computer-assisted learning programs.

SUMMARY AND IMPLICATIONS

Each of the instructional computing program characterictics examined--equipment availability, budgetary considerations, the number of years for which plans have been made, the extent of teaching staff involvement, and the actual and ideal allocation of computer access time--reveal substantial differences between the two groups. The Mature schools have developed plans covering longer periods of time and have established permanent budget line items to ensure the funds needed to implement the plans. The Mature schools invovle a greater number of teachers in their programs and provide a greater ratio of computers to their students. Their programs also place significantly more empahsis on computer applications than on other uses.

Although the differences are often predictable, the findings nevertheless tend to support the accepted maxim that experience makes a difference.

Naturally, established instructional computing programs have been able to acquire more computer equipment and spend more money on its acquisition. These programs have also had more time to involve their teaching staffs in their programs and have had more opportunity to establish solid budgetary foundations for their programs. Since these program considerations require substantial time to develop, recently established instructional computing programs will likely be some years in achieving the level of program stability demonstrated by the Mature schools. However, other aspects of instructional computing programs are more easily controlled by the educational leaders and any guidance that newly established programs receive from the acquired wisdom of the more established schools' computing programs in valuable.

Other instructional aspects in which the more mature programs differ from the newly established programs are less predictably associated with time than those already discussed. The essential consideration of any educational computing program obviously involves how the machines are used. The establshed schools allocate their computer access time in a substantially different manner--devoting 67% more time to computer applications and 28% less time to computer-assisted learning--than those schools with more newly establishedprograms. This difference offers a strong message to educators unsure of which computer mode to emphasize in their programs. Uisng the "computer as a tool" is strongly emphasized in the more mature programs.

The more mature programs have also developed plans which encompass significanlty more time than the more recently established programs. This consideration is equally within the control of educational leaders in a given school. Leaders can combine an awareness of the importance of computer applications in their program with longer term plans which include increased opportunities for teacher training and staff involvement in the planning process. Although the Mature schools, the original pioneers of instructional computing programs can flourish, guidance is available to all educators willing to consider the direction these programs can provide.

These findings have implications for educational leaders at the building, district, and state levels as well as for educational researchers. The results warrant more detailed investigations into other factors which might be influenced by an instructional computing program's relative maturity. Most important, the findings offer guidelines to assist educators in developing the nations's more newly established elementary school instructional computing programs. Clearly, we can still learn more lessons from our elders.

THE FLORIDA EDUCATION AND TRAINING PLACEMENT INFORMATION PROGRAM

M.B. Shaw *

ABSTRACT

The Florida Department of Education, together with the Florida Department of Labor and Employment Security and the United States Department of Defense, have combined their computer capabilities to develop the Florida Education and Training Placement Information Program. By maximizing the use of information stored in the existing administrative data bases of these agencies, accurate, comprehensive, timely and cost-effective follow-up data on former trainees are collected which facilitate an analysis of the quality of publicly funded education and training programs. The majority of former students are from secondary and postsecondary vocational programs and community college programs. In addition, Program data reflect Adult Migrant Education participants, former participants in Job Training Partnership Act programs, and former inmates of correctional facilities who received occupational training while incarcerated.

BACKGROUND

The Florida Education and Training Placement Information Program (hereafter referred to as the Placement Information Program) was born of necessity with respect to two issues: accountability for the millions of tax dollars spent on vocational education and training programs in Florida each year, and; cutbacks in state and federal funding which impact on the development and production of new management information resources.

In the former case, Florida maintains strict standards for the outcomes of employment and training programs. Since 1984, the state has mandated that 70% of all program completers obtain employment which is related to their previous training. The following conditions satisfy the state's criteria for determining a training related placement: the former student obtains employment which utilizes skills acquired through his/her vocational-technical experience; former student is found to be continuing his/her education in one of Florida's community colleges or universities, or; former student has enlisted in military service subsequent to his/her vocational-technical training. This 70% placement rate has meant that each of Florida's sixty-seven district secondary and postsecondary vocational schools has been burdened with developing and

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implementing their own follow-up approach and for the analysis of these data in time for annual state reporting.

Schools, in the past, have used a variety of methods to gather follow-up data on former students including: exit interviews, telephone surveys, questionnaires, and data obtained from Unemployment Insurance Wage Report computer files (referred to as "Labor tapes"). Data collected through these means, however, often only reflect students' intent to use their training in subsequent employment, or a school official's or employer's interpretation of the relatedness of training to employment. Labor tapes provide industry information but do not include occupational data, leaving the examiner to draw his/her own interpretation. This approach to placement information meant that data were gathered and reviewed statewide in an inconsistent manner.

While there is a persistent, urgent need for sound follow-up data for determining program compliance and evaluating program performance, available funding for the production of new information systems has diminished in recent years. Provisions in federal legislation, notably the Job Training Partnership Act, the Carl Perkins Vocational Education Act, the Graham-Rudman-Hollings Budget Balancing Act reflect these cutbacks, and, further, necessitate that information resources be coordinated and consolidated. The development of the Placement Information Program, then, results from and exemplifies a situation which demanded "doing more with less".

TECHNIQUES

The Placement Information Program utilizes a crossmatching approach between the computer files of existing administrative data bases. Common identifiers found in each information resource include the name and social security number belonging to a specific individual. Where there is a "hit", meaning a record is matched between two or more data bases, data are captured which reflect the actual employment, continuing education or military experiences of the former student at the point in time used as a reference.

There are two levels of data collection that occur. One level involves a simple crossmatch to obtain industry/wage data, continuing education and military information; the other involves employer contact to obtain occupational and locational information. When a record is matched with Florida employment files, a brief form is generated and sent to the employer asking for the occupational title and location of employment for each former student listed on the form.

The bulk of students on whom follow-up data are collected come from secondary and postsecondary vocational education programs and community college programs. There were nearly 87,000 former students included in the 1987-88 collection effort on 1986-87 students. Over 20,000 Florida firms were contacted. The 1988-89 effort will increase both the number of students and employers by approximately one-third. The 1988-89 effort, in addition, will include initial crossmatching ventures with the Federal Office of Personnel Management, U.S. Postal Workers personnel files, the state's Department of Personnel Management, and the Florida Department of Corrections.

CONFIDENTIALITY

The Placement Information Program strictly adheres to federal and state statutes governing the disclosure of individually identifiable data and other sensitive items such as student's wages or employer information. These laws require that individual data be regarded and protected as sensitive and highly confidential. Program reports, later compiled from individual records and made available to the public, appear in aggregate form masking individual identifiers.

The state's interest in assessing education and training programs in Florida is the primary justification for the Placement Information Program. As such, students can be assured that data will be used only for this end. No individually identifiable data are available to the general public, nor can these data be accessed electronically.

BENEFITS

Approximately 70% of the former students reported to the Placement Information Program have valid social security numbers. Of these, approximately 75% are found in either military, employment, or continuing education situations. Of those former students found in employment, employers report back occupational titles for about 72%

While the Program's coverage is not 100% complete, the data are defined in such a way that there is statewide consistency in what is collected. Employment data gleaned through the Program's data collection process represent "raw" or primary data by industry and occupation. These data are compatible with occupation and industry data reported through the Florida Occupational Information System and other labor market information programs. In addition to the benefit of consistency, employment, military and continuing education data actually reflect what the former student is doing at a particular time, rather than a student's intent to enter the labor market, enlist in military service, or enroll in continuing education.

The Program's consolidated data collection eliminates the need for former student employment surveys done at public expense. In the past, employers faced a year-round barrage of these surveys conducted by each of Florida's sixty-seven district schools. The Placement Information Program's once-annual employer contact is a boon, particularly with respect to large firms.

The crossmatching approach is cost-effective as the cost for each item of information decreases per unit as one seeks more information. The 1987-88 data collection effort spent $3.82 per student in contrast to approximately $17 spent for surveys done at the local level.

The Program's reports have the potential to significantly reduce the follow-up burden at the local level. Schools are informed early in the Program's data collection cycle of the extent of coverage that will ultimately be provided by the Placement Information Program. In cases where Program data are insufficient for institutions to determine state-related placement requirements, local follow-up specialists may supplement Program data with their own follow-up efforts.

REPORTS

Final local level reports are available in April of each year in sufficient time for schools to meet the state's June 15 reporting requirement. Final state level reports are available in May. These appear in a variety of formats termed "standard reports" which are currently a part of the Program's report repertoire. Reports can also be tailored for studies involving comparisons of wages by program, by race, gender, and by groups with special needs. Data users, which might include school administrators and career counselors, request Program staff to generate a report appropriately formatted for their study objectives. They are then advised of the necessary level of detail which must accompany student records before the crossmatching is effected.

On every occasion where there is a match, meaning a record shows up in two or more data bases, information gleaned from the process is added to the list of data elements already residing in an individual's record. The more detail incorporated in an individual record before crossmatching takes place, the more ways there are to format reports later.

The potential also exists for longitudinal studies of former students to examine likely career paths open to them as a result of their vocational-technical education; remuneration patterns resulting from various training programs, and; programs that deal with the training needs of minorities, the handicapped, and groups with special employment needs.

PREVIEW CENTER GUIDES SOFTWARE PURCHASING

Molly Weeks*

ABSTRACT

In 1983, the Dade County, Florida school district, the fourth largest in the United States, established a software preview center for its teachers and administrators. Visitors to the center view several pieces of software in their areas of interest and receive guidance from various articles, software lists, magazines, and books. Often knowledgeable subject area experts are available for advice. The resulting increased awareness of software content and cost considerations enables school system personnel to make wise purchases of software for their schools.

INTRODUCTION

Federal, local, and state money often comes to a large school system in bursts. School administrators and teachers suddenly find themselves required to buy computer software with funds that must be spent by tomorrow. Often, these people have little or no experience with computers.

To solve this problem and provide a continuing source of software information, the school system in Dade County, Florida maintains a software preview center. Here, school system personnel, teachers from local private schools, and occasionally parents are able to come as needed to view software and learn about its use in all subject areas.

DESCRIPTION

The core of the preview center is software for many areas: language arts, reading, mathematics, science, social studies, primary school, home economics, art, etc. For convenience, when a product is available for several computer models, it is usually obtained for an Apple II, as they predominate in the district. Many items for the Macintosh and IBM PCs and compatibles are also present, usually because they are designed only for these computers or because they run especially well on them.

The lab has ten Apple II computers and several other computers including IBM PCs, an IBM Model 25, a Tandy 1000, and a Macintosh. Most of the computers are attached to printers, so that visitors can test this aspect of the software. At present, they can also see the advantages of the Sequential Systems' Q System for attaching several computers to one printer and Thirdware's Fingerprint card for printing any screen of an Apple program. The room, quite small and crowded, can comfortably serve about ten visitors; a much bigger lab would be highly desirable.

More than a thousand pieces of software are available. Divided by subject area, each piece is marked with its cost and grade levels prominently displayed so that visitors can better choose which products to preview. In each package is a card on which reviewers can note highlights, likes and dislikes, or hints for its operation. A dBASE file of our software is valuable chiefly to check that we have a item. So many commercial software lists are now available that describing items ourselves is not really necessary.

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Choosing from the immense quantities of educational software is necessary. We actively seek to obtain items that are reviewed positively in such respected magazines as *The Computing Teacher*, *Teachers and Computers*, and *Electronic Learning*. We also listen to our district's computer users, who sometimes recommend a product that they are using. In other cases, publishers seek us out and donate their software.

One special collection of software is published by MECC. We have a license to reproduce their software for distribution in our schools. Even though the cost to schools is low, teachers often like to preview it and, at times, we want to demonstrate a collection such as their new science software for elementary schools. So we now have our MECC software handily accessible from a Corvus Omninet hard drive.

The Dade County Software Preview Center is an official software preview center listed by the International Communications Industries Association (ICIA). Membership requires that software kept in the center may not be loaned, may not be copied, and is previewed by potential users. Thus, we are often given software by publishers who find it to their advantage to have highly trained members of the school system displaying and publicizing it. (Valued items are often described in the *Computer News*, a newsletter published monthly for our school system.) We also buy from many publishers who sell software to the preview centers at much reduced prices, generally for 10% to 50% of list price.

VISITORS

Our school system has 260 schools and approximately 14,800 teachers. Because the center can serve so few teachers at a time, reaching very many of our teachers or schools directly is difficult. Generally, visits are scheduled by school administrators who need to send teachers to become aware of what's available in certain subject areas. Sometimes just one teacher comes; more often, several people including the media specialist, the computer lab instructor or aide, and teachers from several levels will come. Working together, they can make an informed decision on the software needed by their school.

The center also holds special software preview days in which about ten teachers in one subject area spend the day previewing software and comparing notes. We try to get subject area supervisors and other specialists to conduct these sessions. This gives them a chance to get to know the material and relate it to the current curriculum.

Before the scheduled day, agendas are sent to all the participants so that an organized presentation can be given.The day begins with an introduction by whoever is leading the session. An overview of the available software is given with demonstrations of special items. These may include especially valuable programs, programs that illustrate a particular quality (such as the use of speech), or programs that are valuable but so complicated that users find them difficult to preview.

The presenter also points out some considerations for software use such as the necessity for thorough teacher knowledge of the content of a product and how to integrate it into the curriculum. Teachers are also told to consider whether a product might be used for a whole class presentation or whether it is suitable for individual or small group use.

Another subject discussed is software packaging. Teachers must consider how extensive a software package is. Are there backup disks? Can extra disks be purchased for the software at a reasonable price? Is the documentation sufficient? Does it provide teacher guidance and activity sheets that add to the value? Issues such as these impact the use of software in the classroom.

The rest of the day is spent individually viewing software, with occasionally other demonstrations. At the end of the day, the teachers discuss the programs that they especially liked or disliked with the reasons for their opinions. The leader may use this information to modify future sessions.

A problem with a preview day is the concentration necessary and the lack of enough time. Looking at software for several hours is exhausting and confusing. Teachers find their minds blurred with the products they saw all running together. We emphasize that they should take notes describing the products they preview.

The Dade County Public Schools usually pays for substitutes so that teachers can visit the center, either on preview days or on their own. Because the money for this is limited and, as noted, we serve a great many teachers, we try to make sure that teachers enrolled for preview days are highly motivated and need the software exposure. However, when preview days are announced, it is the individual school administrators who request that their teachers come. Most of them really value the experience. The occasional ones who are really not interested, often because they have had no opportunity to use computers, usually settle down fascinated as they become involved. Occasionally, the same people come time after time. They no longer find much new and take the place of the many teachers who do need this opportunity.

OTHER SOURCES OF INFORMATION

The impossibility of actually viewing and comparing many computer programs designed for a similar purpose is well recognized. For this reason, all the major publications that deal with using educational computer programs are kept on hand for reference. Articles that cover software for a particular subject in depth are distributed. Another source of information kept in the center are several guides, including the *SEED Software Annotations*, the annual *Educational Software Preview Guides*, and *Software Reports*; these describe and evaluate educational software. In some areas, we have our own lists of software recommended for preview. These are developed by our staff and revised continually as new products appear and we obtain input from our visitors.

Our visitors also need help in purchasing software. A list of publishers with addresses and toll-free phone numbers is given to visitors. Then, they can obtain descriptions and the latest cost information by contacting the publishers for catalogs. We also provide knowledge of publishers with whom Dade County has special buying arrangements, and we point out that local stores often give 20% to 30% discounts from the list price to school buyers.

A variety of books on computers in education are also kept in the preview center. Some are on programming and some on computer literacy topics at many levels, but most deal with using computers as tools for instruction. These and our magazines can be borrowed by school system personnel to widen their awareness of computer use or to provide specific knowledge.

The lab is run by a fulltime staff person whose duties include selecting, acquiring, and maintaining the software collection; scheduling visitors and sending confirmations and agendas to teachers; and preparing and duplicating the software lists and other handouts that we provide. Other staff members conduct preview days in their areas of expertise and keep the hardware up-to-date and working.

FUTURE PLANS

Immediate plans for the preview center include placing many more educational software programs on hard disk for access by a Corvus network. We are also arranging to access integrated learning systems such as PLATO and CCC in the center so that potential customers do not have to visit individual schools to preview them. Finally, we hope soon to move to another building with room for more educators to gather together for a preview of the latest technology.

A FUTURISTIC MANAGEMENT MODEL FOR INTEGRATING ACADEMIC AND TECHNICAL CURRICULA

J.L. English*

ABSTRACT

Basically, the introduction of educational technology into various levels of the U.S. educational system will not be any more successful within the existing traditional top-down management system than any number of other innovation designed to improve education. To address the problem, a participative management model was designed and originally intended for post-secondary application; nowever, constructs and resulting operational components were developed and operationalized in a secondary vocational-technical high school. Traditional academic and vocational departmental organizational units were replaced by occupational clusters while quality circles headed by elected cluster managers were established to manage each cluster. Based on state test data, the school is now ranked in the 99th percentile and has established a national reputation.

INTRODUCTION

While it is no secret that schooling in the U.S. has been and continues to be under scrutiny by many groups and organizations seeking improvement in the product of education, much of the legislation designed to improve the system has done little more than message political egos, and strengthen state controls. Unfortunately, these initiatives, albeit well meaning, have had little or no impact on the improvement of student achievement (ref 1). If meaningful progress is to be made in the quest for quality education in the U.S., innovative leadership and managment models which are the antithesis of top-down models prevalent today, must be implemented within the educational system.

THE DILEMMA

It may well be that the adoption of technological innovations in the educational arena will depend upon the degree to which administrative models include participative management as a basis for decision making. Essentially, public education with its top-down managment model is simply incompatible with the notion of teacher competence (ref 2). Additionally, the top-down syndrome(TDS) accounts for another area of administrative insensitivity--the relationship of education to the work place, especially in a

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competitive international economy.

While this relationship is not new, a number of work place trends have been identified and must be considered by those responsible for decision making involving technology and education (ref 3):

- Six million high skilled executive, professional and technical jobs will be created during the next ten years.
- 1 million new jobs will be created in the next ten years in the less skilled labor category.
- Job specialization will continue to increase in most if not all occupations.
- Specialists working as independent contractors will be in constant demand by corporations.
- Information will be a major product of most industries.
- The service sector will account for 88% of the work force but jobs will be part time with pay scales less than half the level paid in the manufacturing sector.
- Mining, agriculture, construction and manufacturing sectors will continue to decline in terms of the percentage of work force.
- Automated manufacturing technology will increase productivity 500% in those manufacturing industries where the technology is used.
- Computers will create a workplace in the home.
- Computer competency will be required by 100% of the population.
- Women's salaries will be close to men's except in the south.
- The number of Black and Hispanic workers will increase in the labor force.
- Retirement will be later in life.
- Female workers will tend to dominate the

work force.

* Union membership will continue to decline.

As these trends continue to emerge, it is apparent that current administrative models will need to be modified in order to address a new educational agenda created by changing social, economic, and political trends. Teachers will have freedom in an environment created by a participative managment model to foster creative use of not only new technology but also related interpersonal skills as well as an opportunity to design a myriad of innovative solutions to age-old problems. Naisbitt & Aburdene (ref 4) perhaps have best captured the notion:

> The top-down authoritarian management style is yielding to a networking of managment, where people learn from one another horizontally, where everyone is a resource for everyone else, and where each person gets support and assistance from many different directions.

THE SETTING

In 1985, Dauphin County Area Vocational-Technical School, a full-time comprehensive high school, opted to operationalize the model. The school had approximately 900 students with a full complement of vocational and academic programs. However, Dauphin County differs from the typical comprehensive high school in that every student had elected a specific vocational program. In order to operationalize the concepts of participative management, it is appropriate to identify several constructs and list operational components of the model.

MODEL ACTUALIZATION

The following constructs were developed to serve as a theoretical framework for the model:

* Competence, not time must be the hallmark of basic education.

* There is no rational reason to make an artificial dichotomy between academic and vocational education.

* Schools exist for the purpose of education- not for administrative convenience.

* Curricula must be organized to reflect both present and future outcomes.

* The system must be open and responsive.

These constructs were translated into an organizational model. Curriculum was competency based, and clustered; traditional academic departments eliminated with staff assigned to each of four clusters: (1) construction, (2) manufacturing, (3) service, and (4) communication/transportation. Cluster managers were elected and quality circles used to manage each cluster; staff training was a continuous process with university support; supervisors and administrators participated in an intensive graduate vocational education leadership program at Temple University; communications were open while the management style was democratic.

RESULTS

By abolishing academic departments and establishing occupational clusters as units of organization that included both vocational and academic teachers as equals, curriculum integration was a natural outcome. While the process certainly was not smooth and not without conflict, it did, however, foster an environment where for the first time in many years, vocational and academic teachers were talking, working, planning and organizing together for the purpose of providing integrated and horizontally articulated instruction. As a result, based on current state-wide test scores, Dauphin County AVTS now score in the 99th percentile (ref 5). Additionally, the school has received national visibility and continues to host visitors from many states.

A free video (VHS) tape which chronicles the transitive process is available from the author. Other information maybe obtained from: Mr. R. Stammel, Director, Dauphin County AVTS, 6001 Locust Lane, Harrisburg, Pennsylvania (17109).

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2 U Casanova, NEA Today Vol 7, 48 (January 1988)
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4. Naisbitt & Aburdene, Re-inventing the Corporation, (Warner Communications, NY 1985) p 62.
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COMPARISON OF METHODOLOGIES FOR PUPIL ENROLLMENT FORECASTING

J.H. McKnight*

ABSTRACT

State educational agencies and school districts plan and make significant decisions daily which impact on finances, personnel, facilities, new construction and union agreements. Most of these decisions depend upon a grasp of the current and future resources of the organization. In secondary schools these resources are determined at some point by the number of students projected to attend school in the district or state. Allocation and decision making processes must be underpinned by an accurate method of forecasting pupil populations. Current methods produce varying results depending upon the student population stability of the district. The focus of this research, which is just underway, is upon the evaluation of selected enrollment forecasting models to determine which model provides the best accuracy under varying conditions.

INTRODUCTION

Forecasts, beyond five years, are difficult to predict because live birth data limitations force extrapolated enrollment figures to be used. If projections at the initial entry level, generally kindergarten or first grade, are not accurate, later projection periods will be very inaccurate. The application of Operations Research to educational problems, specifically pupil population projections, reduces decision making under risk or uncertainty in school systems with increasing or decreasing populations. School systems with stable populations permit a greater degree of certainty to be assumed about the setting, allowing less difficult decisions to be made.

A major task of the OR researcher is to select and employ appropriate quantitative models to address the problem. Relevant mathematical models include descriptive, normative and predictive approaches. Descriptive models generally describe and define problems and components but fail to provide solutions of "best fit" to enable the best decision to be made. Normative models, often referred to as optimization models provide direction to managers in deciding which course of action best responds to their needs. Predictive models forecast the future.

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Two general types of models are commonly used in seeking solutions to management problems. The first type, deterministic models, employ the use of variables and relationships which are known to the researcher. The second type of model, the stochastic model, responds to variables and relationships which are not known with certainty to the researcher. In both instances the variables involved cannot be controlled by the investigator. Data collected for use in these models will be data that describe the uncontrollable variables. Forecasting methodology depends heavily upon historical data to project the future. Stochastic modeling is proposed for use in this research.

The primary category of forecasting model available to researchers is the projection model. Projection models include both qualitative and quantitative models and are used when there is a historical data base reflecting stable trends and relationships. Qualitative forecasting methods such as the Delphi method, market research, panel consensus and historical analogy are frequently used by researchers or planners to find solutions to problems. These methods are not as appropriate for pupil population forecasting since quantitative methods lend themselves to the arithmetic analysis being performed. Both processes have appropriate applications.

A review of the literature on pupil population forecasting reveals that a concentration of research efforts occurred in the late 1960's and throughout the 1970's. A combination of socio-economic factors pointed out the need for accurate pupil population forecasts for critical decisions. It was recognized that the baby boom, integration, inner city decline and urban growth were causing school age populations to be increasingly difficult, yet critical to predict.

METHODOLOGY

A variety of methods have been identified for the research focus of this study. A brief overview is provided.

Ratio methods are the most commonly used approaches to forecasting pupil population projections. While there are many ways to design ratio projection methods, all of them express a mathematical relationship between groups of students at two or more different points in time. The basic assumption that most ratio methods have in common is that certain variables which have occurred in the past will continue in the future. In practice then, a ratio projection assumes that the socio-economic interrelationships which have occurred in the past will stay constant. Researchers differ on the length of history to use in forecasting but it is generally agreed that the more historical data the better some projections will be.

Vertical v. Horizontal. Most projection methods utilize a historical enrollment base for projection. This somewhat traditional approach could be said to be a vertical type of projection since, if depicted in a graph, an initial entry projection is related to births either five or six years previous. The researcher proposes to compare the historical, or vertical method, to another method best described as a horizontal method of analysis. The horizontal method utilizes a record of several years of births to project births beyond the point for which data normally exists. Births, if depicted graphically, run across a horizontal axis, thus the label horizontal. Projections using the horizontal and vertical methods of enrollment forecasting will be tested using both geometric and linear algorithms. Calculations will be completed and the mean square error for each algorithm analyzed.

Regression methods are not found as frequently in the literature but have been used by a few researchers to forecast pupil population projections. Regression methods proposed for this study assume a straight line relationship between X and Y. Imperfect relationships between the predicted Y and the observed Y are expressed as prediction errors. The straight line relationship minimizes errors.

Time series analysis is a special form of regression and is used to study change related to time. Independent variables (yearly enrollments) collected over time (once a year for a number of years) can be incorporated in a special time series equation to forecast future enrollments for a grade or series of grades. Time series regression differs from the regular regression mathematics in one special way - the order of the independent variables in the equation is of utmost importance. Once data is incorporated in an ordered sequence it can be examined to see how it has performed in the past and project how it will perform in the future. Very little attention has been focused on time series regression methods by educational forecasters.

Markov processes are probabilistic models which apply to dynamic systems over time. Few researchers have applied Markov to school enrollment forecasting.

The particular Markov process which has application for pupil population forecasting is known as an absorbing model in which the characteristic absorbing state is defined as having a zero probability of being left once it is entered. A Markov process is a stochastic process for which the occurrence of a future state depends only on the immediately preceding state. Thus, for a Markov process, given that the present state is known, the conditional probability of the next state is independent of the states prior to the present state. Markov models do not rely on history, only present information is used to forecast the future.

Curve fitting methods are mathematical applications appropriate for forecasting student enrollments through the use of historical data. At least three types of curves can be used in estimating enrollments.

Exponential smoothing can be classified as a special type of weighted moving average. Generally, more recent data is given increased weight since it is more likely to accurately depict recent demands or phenomenon. The exponential smoothing process is not linear. Past data values are smoothed to product a forecast. Data requirements are less difficult for this method since only a single data set (a specific year or average of several years) is used to initiate the forecast. The process has an element of subjectivity to it since the researcher must identify the exponential value to be used in the formula to smooth the curve.

The Gompertz curve, named for Benjamin Gompertz, produces a straight line equation using log log values. Three representative data points are selected for use in this procedure to forecast enrollment.

The logistic curve is a curve which describes population growth. It was conceptualized in the early nineteenth century by the Belgian mathematician Verhulst and revised by others. Curve fitting methods can incorporate methods such as the rate of increase where enrollment is viewed as increasing in a linear fashion or can use selected data points for projections.

SUMMARY

The outcome of the research may provide an answer to the issue of which model provides the best pupil population enrollment projection for specific growth patterns.

FLOW OF DOCTORAL CANDIDATES THROUGH A UNIVERSITY PROGRAM: AN APPLICATION OF ABSORBING MARKOV ANALYSIS

Robert C. Tart*

ABSTRACT

The development of microcomputer software for operations research has begun to provide a new option for educators in decision-making positions. An example of this is the application of absorbing Markovian analysis to the flow of doctoral candidates through a university program. In addition to defining the flow of students, this application of operations research in educational administration has implications for the adoption of admission standards for the program being studied, and provides data that can be important in scheduling resources, advisors, and other support required by the department.

INTRODUCTION

In order to effectively and efficiently plan for the flow of doctoral candidates through a university program, administrators must utilize the best information available. One set of data that would be valuable to the university department chairperson would be that composed of the probable flow of the candidates through the various stages of the program, the number of candidates that might be anticipated in any one stage at any given time, the number of candidates that can be anticipated to complete the program, and the amount of time that candidates might spend in any one stage. These questions and others were addressed in an analysis of doctoral students in the North Carolina State University doctoral program in educational administration (ref 1). The following stages were determined to be relevant to the department's needs:

STAGE	DESCRIPTION
1	Doctoral students have completed from 0 to 24 hours of course work
2	Doctoral students have completed from 25 to 48 hours of course work
3	Doctoral students have completed over 48 hours of course work but have not passed comprehensive exams

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4 Doctoral students have completed comprehensive exams and are working on proposals

5 Doctoral students have completed all work and the degree has been awarded or is pending

6 Doctoral students withdrew from the program voluntarily or exceeded the time limit

7 Doctoral students dropped due to academic difficulty

A Markov model was selected to analyze the flow of students through these defined stages.

THE MARKOV ANALYSIS

The Markov analysis is a probabilistic model common to management science. It is the principal tool for evaluating the transition matrix--a square array of probabilities indicating the likelihood of passing from one state to another. In order to utilize the Markov technique several assumptions must be made:

1. A finite number of discrete states exists. The occurrence of a future state depends on the immediately preceding state and only on it.
2. The transition probability of moving from one state to another in one time period must be independent of all prior states except the current one.
3. The total of transition probabilities of moving from a given state to an alternative state in the next time period must equal 1.0.
4. Probabilities must be reasonably constant over time.
5. All info needed to construct a complete transtition matrix must be available (ref 2).
6. If an absorbing analysis is being completed, the process must have at least one absorbing state and at least one path from each non-absorbing state. (Absorbing state k exists in the model when the chain visits state k and remains there forever (ref 3).

Probabilities can be obtained through a series of matrix operations. The time and effort involved in this process require the availability of computers in order for the applications to be practical in education. The microcomputer has become an inexpensive and available tool that administrators in education can utilize in order to take advantage of this technique (ref 2).

In this application, 143 observed transitions of doctoral candidates through the stages of the program were recorded. The proportions (conditional probabilities) for each observed state are recorded in Table 1. The status of each student in the study was determined annually on October 1. When the data is entered for the Markovian application, the resulting analysis yields three additional tables:

Table 2 Expected steps (years) to absorbtion (final stage of program)

Example: Of all the students who, one year ago, had completed 25-48 credit hours but who had not yet passed their comprehensive exams, we may expect them to be enrolled 7.96 years.

Table 3 Expected number of times (years) a process (doctoral student) will be in a specific nonabsorbing state (stage of the program) given a specific starting state (observations from previous year)

Example: On the average, those 7.96 years in the example above will be used as follows: 3.57 years in Stage 2, 1.19 years in stage 3 (a total of 4.76 years to go in course work), 3.20 years passing the comps and working on the proposal.

Table 4 Probability of being trapped by a specific absorbing state given a specific starting state (probability of being trapped in one stage of the program given a particular starting stage)

Example: Students who had completed 25-48 hours a year ago may be expected to leave the system as follows: 93% will complete the degree, 7% will withdraw voluntarily or exceed the time limit, and none will drop due to academic difficulty (ref 1).

IMPLICATIONS

The application above is just one example of how the Markov technique can be applied in the educational arena. With programs developed for the microcomputer, the use of this operations research method is no longer limited to those who have access to mainframe computers. With increased accessability comes greater opportunities for educational administrators to utilize better defined and more precise information in their decision-making processes. The expanded uses for such software are limited only by the assumptions of the technique. Further exploration of the possible applications for the Markov technique are warranted in the light of the variety and volume of high impact decisions that educational administrators must make while facing demands for improved effectiveness, efficiency, and accountability.

TABLES

TABLE 1
CONDITIONAL PROBABILITIES OF TRANSITIONS BETWEEN STATES

		To State						
		1	2	3	4	5	6	7
	1	.62	.28		.02		.07	.02
	2		.72	.21	.05		.02	
	3			.37	.63			
To	4				.71	.29		
State	5					1.00		
	6						1.00	
	7							1.00

TABLE 2
EXPECTED STEPS TO ABSORBTION

FROM STATE 1: STEPS = 8.46
FROM STATE 2: STEPS = 7.96
FROM STATE 3: STEPS = 5.04
FROM STATE 4: STEPS = 3.45

TABLE 3
EXPECTED NUMBER OF TIMES A PROCESS WILL BE IN A SPECIFIC NONABSORBING STATE, GIVEN A SPECIFIC STARTING STATE

Beginning State	Number of times in State . . .			
	1	2	3	4
1	2.564	2.564	0.855	2.476
2	0.000	3.571	1.190	3.202
3	0.000	0.000	1.587	3.448
4	0.000	0.000	0.000	3.448

TABLE 4
PROBABILITY OF BEING TRAPPED BY A SPECIFIC ABSORBING STATE GIVEN A SPECIFIC STARTING STATE

From State	Trapped by State . . .		
	5	6	7
1	0.718	0.231	0.051
2	0.929	0.071	0.000
3	1.000	0.000	0.000
4	1.000	0.000	0.000

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REDUCING RISK AND UNCERTAINTY THROUGH COMPUTER-AIDED DECISION MAKING IN EDUCATIONAL ADMINISTRATION

R.G. Taylor *

Many administrative decisions in education are made under conditions of substantial uncertainty; most events occurring in educational systems can only be estimated or predicted. Educational managers have used deterministic decision tools with increasing frequency in the last decade (ref 1), but the use of formal predictive or probabilistic methods has been infrequent (ref 2). Given the uncertainties which characterize educational management, and the suggestion that many decision makers have difficulty using probabilistic information (ref 3), this is unfortunate.

The purpose of this article is to illustrate the use of one probabilistic decision method, Bayesian analysis. It is a stochastic technique used to reduce uncertainty by improving the accuracy of probability data. When the resulting probabilities are combined with data pertaining to loss functions, personal values, and/or preferences (ref 4), Bayesian analysis becomes a powerful decision analysis technique.

Bayesian analysis uses new data (the likelihood of one condition given another) to revise previously held expectations (prior or unconditional probabilities), which are usually linked to known or supported base rate information. These revised beliefs (posterior or conditional probabilities) can then be combined with other pertinent data, such as loss functions, to optimize probabilistic decisions.

In the following application, Bayesian analysis is used to determine which decision will minimize financial loss to the district on "snow days": opening schools, starting late, or closing schools. The decision involves discrete events, incrementally changing conditions, and an objective loss function. The application modeled here does not account for social costs or subjective utilities.

Illustration

During winter months, many superintendents face the threat of inclement weather which can jeopardize the lives of students and faculty, as well as the financial condition of the district. Each winter morning, school administrators are likely to receive one of four weather forecasts: (A) good; (B) marginal, but improving; (C) marginal, but deteriorating; or (D) poor. Despite the forecasts, the day will ultimately be one in which schools should have been open (by definition here, "good," State 1) or closed ("poor," State 2). These two conditions are known as "states of nature."

During winter months (December-February), in the Northeastern United States where these data were obtained, the weather is generally "good" 18.5 out of 20 work days each month. Hence, the prior probability of states of nature 1 and 2 is .925 and .075, respectively.

Weather forecast information can be purchased from a commercial forecasting company out of state. The actual rate of success and the costs of these services varies slightly by region. For illustrative purposes, presume that the cost is $500 per season, and that the conditional probabilities associated with each type of weather forecast offered by the company are summarized for each state of nature in Table 1.

Table 1
Conditional and Posterior Probabilities

	(Weather "Good") (1)		(Weather "Poor") (2)	
Company Forecast	Conditional	Posterior	Conditional	Posterior
A. Good	.70	.9942	.05	.0057
B. Improving	.15	.9487	.10	.0512
C. Deteriorating	.10	.8915	.15	.1084
D. Poor	.05	.4683	.70	.5316

The conditional probabilities for each state of nature, as in Columns A and C, are interpreted as follows. When the actual weather was good, the company's forecast was correct 70 percent of the time. When the company claimed the weather would be marginal, but improving, it was accurate 15 percent of the time, and so on. Using the Bayesian formula for converting prior to posterior probabilities, columns B and D were found.

Upon receiving weather information, school officials can take one of three actions: (1) open school, (2) open late, thereby delaying the final decision, or (3) close school. In each case there are financial, social, and political costs, though only financial costs are considered here.

In order to calculate the loss function, the costs of resources in the district must be known. This analysis is based on wage rates, waiting times, penalties and employment agreements derived from the public records of one school system. The loss function appears in Table 2. In this application, the loss function is defined as follows. If school is opened and the weather turns out to be good, then the loss is zero. If school officials elect a late opening and the weather turns out to be good, the bus drivers will be owed two hours of wait time plus one hour of overtime at the end of the day, for a cost of $1500. If school is closed and the weather turns out to be good, a cost of $900 is incurred. If school is open and the weather turns out to be poor, a $10,100 loss results; mostly due to lost labor, spoiled food, aborted bus runs, emergency plowing, etc. All of the losses reported in Table 2, are derived from costs associated with waiting and overtime for bus drivers, cafeteria workers, loss of food (when schools are delayed and then closed), the salaries of aides, and other costs.

Weighted loss functions were calculated by multiplying the loss function for each action by the prior (unconditional) probability of each state of nature. Subsequently, expected losses for each action were obtained by summing the weighted losses of both states of nature for each action. These are the losses expected if only base line data for the probability of snow are available.

Initial loss functions are then revised to incorporate the cost of forecast data. Assuming a cost of $500 per season, each initial loss function is revised upward by that amount. (It should be noted that the costs of information such as this can be spread by sharing both the information and cost among a group of districts in the same geographic area of a state, and that such costs can be spread across several analyses within one school district.) These revised loss functions are used to compute revised expected loss functions associated with each possible action.

Table 2

Distribution of Loss Functions, Weighted Loss Functions, Total Weighted Expected Losses, and Revised Loss Functions for Two States of Nature.

Actions	(1) Weather Good		(2) Weather Poor
1 Open School Loss	$0.00		$10,100.00
Weighted	0.00		757.50
Expected, on time		757.50	
Revised Loss	500.00		10,600.00
2 Open Late Loss	1,500.00		3,100.00
Weighted	1,387.50		232.50
Expected, late		1,620.00	
Revised Loss	2,000.00		3,600.00
3 Close School Loss	900.00		200.00
Weighted	832.50		15.00
Expected, close		847.50	
Revised Loss	1,400.00		700.00

The revised expected loss functions for the three possible actions that school officials can take after receiving each forecast is computed as follows. The posterior (conditional) probability for the forecast A in the first state of nature is multiplied by the appropriate revised loss function and added to the product of the posterior probability for the forecast A in the second state of nature and its revised loss function. See Table 3.

Optimal decisions, those which minimize school district losses, for each forecast condition are obvious in Table 3. Unless the forecast is for poor weather, it is less costly to open schools despite the weather forecast than it is to delay the opening.

Table 3

Revised Expected Loss Functions For Four Forecasts With Three Possible Decisions For Each

Forecast	Open	Open Late	Close
A Good	$557.52	$2,008.92	$1,395.87
B Improving	1,017.07	4,090.64	2,759.89
C Deteriorating	1,594.79	6,263.88	4,083.87
D Poor	5,869.11	9,114.24	5,111.61

The Unconditional Expected Loss with Experimentation (UELE) occurs when school officials consistently select the optimal actions for each forecast (refer to Table 3). In this example, UELE is $1,182.

The Expected Value of Sample Information (EVSI) indicates the reduction in loss resulting from the commercial forecast, without considering the cost of that information. EVSI in this case is $75.

The Expected Net Gain from Sampling (ENGS) reflects the extent to which the value of the forecast exceeds its cost. Hence, ENGS is -$425. However, if the district anticipated using the service throughout the season, ENGS would be positive.

The Expected Value of Perfect Information (EVPI) is computed by subtracting the expected loss with perfect information from the smallest expected loss among the three actions. This difference, ($742) is the amount school officials should be willing to pay for perfect forecast information, if it were available. No matter how good the forecast information is, it can never be worth more than the EVPI.

Summary

Bayesian analysis offers school business officials a method for reducing the uncertainty and financial risk of some decisions. In addition to identifying optimal actions under different conditions, Bayesian analysis yields information about the value of services purchased to improve decision estimates. With a few additional calculations, the technique specifies the value that school officials should be willing to pay for perfect information--information that would reduce decision uncertainty, but not necessarily expected loss.

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OPERATIONS RESEARCH IN EDUCATIONAL ADMINISTRATION: A THREE DECADE RETROSPECTIVE

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ABSTRACT

This paper summarizes the applications of selected operations research techniques which have been reported during the 1960's, 1970's, and 1980's in the generally available educational administration and planning literature. The paper briefly describes the selected techniques, summarizes the types of applications which have been most commonly reported, and indicates the relative frequency with which the techniques were used in each of the decades.

INTRODUCTION

Operations research is a field of study developed in the twentieth century which seeks to improve managerial decision-making through the use of quantitative techniques. These techniques seek to order decision variables in logical, systematic, mathematical relationships, called models, whose solutions assist managers in reaching decisions (ref 1). The general types of decisions and the operations research techniques selected for review in this paper are: Making optimal allocation decisions (linear programming, integer programming, zero-one programming, and goal programming); Network analyses, for decisions involving the order and timing of events (program evaluation and review technique) and decisions involving routing (shortest route and spanning tree analyses); And, decisions based on forecasting (Markov analysis, Bayesian decision analysis, and forecasting).

MAKING OPTIMAL ALLOCATION DECISIONS

A. Description of techniques. Educational administrators must frequently make allocation decisions regarding to which purposes resources are to be put and what quantities are to be used. In view of the pervasiveness of allocation decisions, it is not surprising that the most commonly reported operations research technique in the literature is linear programming (LP). LP is used when there is a goal of maximizing the benefits or minimizing the costs which may be generated by a mix of given quantities of resources. The decision variables must be quantifiable in LP and capable of being combined into equations; one of the variables must be optimized through an equation containing the other variables. There are several more sophisticated variants of LP. One of these is integer programming in which the optimizing solutions must be in integer terms to be sensible (LP permits fractional values for the decision variables in the optimizing solution). One type of integer programming is zero-one or binary programming in which the decision variables in the optimizing solution must be either zero or one. Another member of this family of techniques is goal programming, in which there are several goals that the decision-maker can include in the formulation of the problem. The goals are given priority ranking and the problem solution is optimal with respect to the manager's established priorities.

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B. Types of applications. Reported LP applications have included salary planning models, school transportation system design, school menu planning, and bus scheduling and assignment of pupils to schools. The educational administration and planning literature use of LP is summarized in two recent articles (ref 2 and 3). Integer programming applications have been more limited. The applications reported in the literature include development of budget reduction strategies for higher education programs, maximizing interest earnings from investments and loans by school districts, designing space allocation for libraries, and determination of distribution of memory units in information systems (ref 4). The only reports of zero-one programming in the literature are the uses in developing budget reduction strategies and the interest maximization strategies noted above and in selecting school revenue generating events (ref 5). Reported applications of goal programming in the literature include estimating student flows, allocating resources to achieve student progress, school and university planning and budgeting, cutting programs, allocating manpower resources, achieving racial balance in schools, salary planning, class scheduling, and busing.

C. Frequency during decades. As reported in the generally available literature, the use of LP reached its peak during the 1970's. There were nearly twice as many reported applications during that decade as in the 1960's and 1980's combined. There were about twice as many reports of the use of LP in the 1980's as there were in the 1960's. Roughly the same pattern held for goal programming — approximately twice as many reports appeared in the literature during the 1970's as in the other two decades combined, and many more reports appeared in the 1980's than in the 1960's. The greatest numbers of reports of integer programming and zero-one programming, however, have been in the 1980's. There were no reports of the application of either technique in the 1960's and no reports of the use of zero-one programming in the 1970's.

NETWORK ANALYSES

A. Description of techniques. Generally, there are two types of network analyses that can be useful to managers: those involving the order and timing of events or activities and those involving routing something through a series of points. An example of the former is program evaluation and review technique (PERT). Examples of the latter are shortest route and spanning tree analyses. PERT can be a valuable tool for planning and controlling a complex project. PERT at its most sophisticated involves careful delineation of all events or activities which must be accomplished in a project, identification of necessary order of occurrence for those activities, estimates of probable, pessimistic, and optimistic times for completion of the activities, and calculation of time and time variance for the critical and near critical paths of events for the project. Not all PERT applications are probabilistic, however. The routing analyses typically start with a series of points that need to be connected through activities. Particular applications may limit the number of times each point may be included in the network and the direction of the flow of activities through the network. Shortest route analyses seek the shortest route through a network without necessarily going through each point in the network. Spanning tree analyses seek to find the shortest route through the network and provide a route which connects each point to the path through the network.

B. Types of applications. PERT applications reported in the literature include the operation of training programs, the implementation of occupational field studies, making student referrals, establishing a new college, appointment of an advisory committee, planning of facilities, establishing caseloads for teachers of handicapped children, organization of distributive education, scheduling learning programs, and scheduling budget development activities. Very few of these applications involved probabilistic estimates of time (ref 6). There were no reports of shortest route applications and only three reports of minimum spanning tree analyses (relating to search terms in information systems, theoretical graphing issues, and a capital budgeting problem) in the generally available educational administration and planning literature (ref 7).

C. Frequency during decades. The greatest number of reports of the use of PERT occurred in the 1970's, equalling more than twice the total number of reports in the 1960's and 1980's. Surprisingly, the number of reports in the literature in the 1960's was approximately twice the number reported in the 1980's. As noted above, there were no reports of the use of shortest route analyses in the literature and only three reports of the use of spanning tree analysis, one in the 1960's and two in the 1980's.

FORECASTING

A. Description of techniques. Several operations research techniques are available to educational administrators to assist them in making forecasts. Some of the models are probabilistic; that is, they incorporate estimates of risk or uncertainty. Other models utilize statistical methods for extrapolating from historical data to make projections for the future. Examples of the former are Markov analysis and Bayesian decision theory; examples of the latter are ratio, regression, geometric, and linear projection techniques. Markov analysis requires that there be a known number of states into which the objects under study may move, that the probabilities of moving from one state to the next are known and are reasonably constant over time, and that the total of all probabilities of moving from one state to another and of staying in the same state equals one. Markov analysis of a system, given these conditions, allows the administrator to make forecasts of future states of the system. In one type of analysis, absorbing Markov, one or more of the states can be such that there is no movement from the states once they have been entered. Bayesian decision theory involves the combination of known probabilities of events based on experience and of probabilities based on beliefs or expectations held by the decision-maker (called prior probabilities). The combination of these two types of probabilities is a set of conditional probabilities relating to the events under study. These can be used with data related to the expected value (benefits and losses) associated with each course of action to identify the optimal choice for the administrator. Ratio, regression, geometric, and linear forecasting techniques use historical data to make projections. Adjustments can be made to the projections to take into account seasonal or cyclical factors. Weights can be given to the historical data and smoothing techniques can reduce the variation in projections produced by reliance on discrete historical data.

B. Types of applications. Markov analyses have been used in educational administration and planning for forecasting student flows and enrollments, planning for industrial education, predicting the behavior of educational administrators, forecasting teacher mobility within a school district, analyzing staffing policies, projecting housing values and racial mix for school districts, and for forecasting and budgeting for the salaries of teachers in a school district (ref 8). The only explicit absorbing Markov analysis reported has been used in studying human resource issues (ref 9). Bayesian decision theory has been used for indexing source documents, personnel selection, testing and classification of students, information retrieval, and program evaluation (ref 10). Virtually all reports of the deterministic forecasting techniques have been for projecting student enrollments.

C. Frequency during decades. The greatest number of reports of the use of Markov analyses has occurred during the 1980's. The number of reports in this decade exceeds the total number reported in the 1960's and 1970's, with nearly twice as many reports occurring in the 1970's as in the 1960's. Most reports of Bayesian decision theory have occurred in the 1980's. There was one report of Bayesian analysis in the 1970's and none in the 1960's. There were relatively few reports of deterministic forecasting applications during the 1960's. The greatest number occurred during the 1970's, equalling approximately twice the number of reports in the 1980's.

DISCUSSION

There have been many reports of a wide variety of applications of operations research techniques to educational administration and planning problems during the past three decades. Applications of deterministic techniques (linear, integer, zero-one, and goal programming, PERT, spanning tree, and forecasting) easily outnumbered applications of the probabilistic methods (Markov and Bayesian analyses and probabilistic PERT). A majority of studies which used deterministic techniques reported applications of either LP or forecasting. Among the probabilistic techniques, Markov applications were reported the most often, Bayesian analyses were next most common, and probabilistic PERT applications were rare. In general, the decade in which most deterministic techniques were reported was the 1970's. Approximately twice as many deterministic studies were reported in that decade as in the 1980's and approximately twice as many studies were reported in the 1980's as in the 1960's. Only the infrequently used deterministic techniques (integer and zero-one programming and spanning tree analysis did not conform to this pattern). Approximately two-thirds of the reported applications of the three probabilistic techniques were in the 1980's; approximately twice as many applications were reported in the 1970's as were in the 1960's.

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WRITING IN AN INTEGRATED TOOL ENVIRONMENT

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ABSTRACT

The use of microcomputers in Language Arts is often associated with text editors. Commercial text editors are not suitable for learning purposes, although their use are widespread in schools.

There are some exceptions, as the LogoWriter editor, which allows students to mix text and graphics. There are few products which deal with grammars concepts.

WRITE is an integrated environment including text and graphic editors, several dictionaries -synonyms, antonyms and meanings, a speller, a grammar tutorial and a small expert system.

The graphic editor allows the user to create images in a simple way, and to include it inside texts.

The speller can be used in different ways, as specified by the teacher: showing a list of the probable correct spellings, or just indicating the words not recognized. The second case can be used when the student must search by himself the grammar rule which can help him correct the mistake. In this case the grammar rules will be available in an hypertext.

Because verbs in Portuguese are very difficult to conjugate, a small expert system can deal with this kind of problem. The student can also ask the "expert" to do a syntactical analysis of a specific sentence, a group of them, or the whole text. A simple dialogue between the system and the student simplifies the system comprehension of the sentence and the student understanding of the syntax rules.

The user interface is very simple, although friendly, based on the concepts of windows, functions keys, and pull down menus.

The main purpose of this environment is to help the student learn grammar concepts while he is writing his composition.

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PROCESS WRITING IN VOLUSIA COUNTY SCHOOLS

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ABSTRACT

Process Writing, a program in the School District of Volusia County, integrates the writing process--prewriting, drafting, revising and publishing--with word processing. Elementary students and secondary language arts students are provided an opportunity to use technology as a viable tool in the classroom.

INTRODUCTION

Writing is an essential skill. When a student writes, a permanent, instantly retrievable record of experiences is created. Writing demands conceptualization, organization, categorizing and arranging. Writing gives the teacher access to the thinking process that far exceeds what the teacher can determine from class participation or objective tests.

With the District's emphasis on writing, and with a full understanding of the importance of students' need to use technology, the logical placement for computers was the writing classroom. Five thousand computers were purchased, and thirty-five Writing to Read Labs for kindergarten students were established for the purpose of providing writing and word processing experiences for all elementary and all secondary language arts students in a school district that serves approximately 43,000 students. The distribution of the computers was as follows:

Kindergarten - Writing to Read Lab and a lab assistant for every elementary school.
2 - 6 - Four computers and one printer per class.
7 - 9 - Four computers and one printer per English classroom only.
10 - 12 - Five computers and two printers per English classroom only.

In the Process Writing Program all the students maintain a writing folder. Their handwritten and computer generated materials are filed in the folder. A pocket folder often is used to place the student's private disk inside for written pieces he does not choose to print. As the students use the word processor for their creative stories, poems and formal paragraph or report writing, the computer skills they learn adequately cover minimum computer skills mandated by the Department of Education. No additional computer classes will be taught to pass this minimum state test except in the middle schools when programming must be addressed. Process Writing has integrated technology with writing, enhancing students' writing and technological abilities.

RESULTS

Since the main objective was to improve writing using the computer as the writing tool, pre-test and post-test writing samples were obtained. The analysis of the differences in mean holistic scores, comparing students in the winter of 1986 (before using the computers) and the spring of 1988 (after using the computers for one full year), is contained in Table I. This table is based on grades four, seven, and eleven. The t-test for these groups indicated that students performed significantly better than their counterparts in the winter of 1986.

The analysis of differences in mean diagnostic scores in the areas of content, organization, usage/sentence structure and mechanics is contained in Table Ia. The t-test indicated that students in the spring of 1988 in grades four, seven and eleven performed significantly better than their predecessors in the winter of 1986 in all diagnostic areas except in organization in grade four and in usage/sentence structure in grade eleven. These results are consistent with the findings based on the overall holistic writing score. They suggest that emphasis on teaching the writing process resulted in a definite improvement in writing.

The surveys completed and the on-site visitations to the classrooms clearly indicated that the computers provided incentives for students to write more and changed their attitudes toward writing. Students scrutinized their own work and shared their written pieces. More revision took place, with students being proud of the finished products.

CONCLUSIONS TO DATE

1. Reluctant writers write more and are willing to reread and revise their work.

2. Teacher inservice is a key to any successful program. Teachers in the Process Writing Program need instruction in use of the word processor and instruction in the writing process.

3. Process Writing instruction varies according to grade level and student ability, requiring flexible management techniques in the classroom.

4. Classroom management is a major concern for teachers as this program constitutes a change for some teachers.

5. Ability to keyboard is a major concern of students; this is being addressed in the fifth grade, 1988-89.

TABLE I

Analysis of Differences in Mean Writing Scores for Grades 4, 7, 11, from Winter 1986 to Spring 1988

Grade	Winter 1986 (mean score)	Spring 1988 (mean score)	T-Value	Probability
4	3.0 N=238	3.3 N=355	2.94	.02*
7	2.9 N=244	3.7 N=420	8.10	.001*
11	3.1 N=189	3.8 N=993	3.80	.001*

* = Significant Difference in Mean Scores at .05 Level

SCORING AND TABLES PREPARED BY AMERICAN TESTRONICS, RESEARCH DEPARTMENT

TABLE Ia
Analysis of Differences in Mean Diagnostic Scores for Grades 4, 7, 11 from Winter 1986 to Spring 1988

Diagnostic Area	Grade	Winter 1986 Mean Score	N 1986	Spring 1988	N 1988	t-value	Probability
Content	4	3.08	238	3.29	355	2.0*	0.05
"	7	2.96	244	3.59	420	6.1*	.001
"	11	3.23	189	3.88	993	7.1*	.001
Organization	4	3.19	238	3.16	355	-.28	Not significant
"	7	2.89	244	3.77	420	8.7*	.001
"	11	3.14	189	3.67	993	5.8*	.001
Usage/Sentence Structure	4	2.59	238	2.83	355	2.2*	.05
"	7	2.61	244	3.55	420	9.7*	.001
"	11	3.54	189	3.67	993	1.4	Not significant
Mechanics	4	2.75	238	3.03	355	2.6*	.02
"	7	2.78	244	3.86	420	11.1*	.001
"	11	3.56	189	3.76	993	2.2*	.05

*Significant Difference in Mean Score at .05 Level

SCORING AND TABLES PREPARED BY AMERICAN TESTRONICS, RESEARCH DEPARTMENT

The impact of Desk Top Publishing in Primary and Secondary Education: report on several case studies undertaken in U.K. schools

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Many workers including some of our team have studied and reported the impact of Word-Processing in schools. We are currently concerned with the impact of Desk Top Publishing (DTP) in schools as a means of preparing learning materials outside of the classroom, as a writing/communication learning resource, and as a vehicle for communication studies projects. We also identified schools beginning to use DTP for developing their corporate identity with in-house style sheets as well as for record keeping and related adminstration using 'forms' facilities. Our research team comprised staff with expertise/experience of teacher education and training together with a high level of skills and knowledge in the technology of Desk Top Publishing per se. This paper describes some of our early findings and discusses issues concerned with methodology, applications and new concerns.

The paper will discuss FOUR different categories of DTP applications in schools and colleges which we have studied.

a) the use of DTP outside of the classroom by teachers to prepare teaching materials

b) the use of a DTP facility in the classroom.

c) the extension of the media studies curriculum

d) the development of quality communication system to parents, governors etc

Category a)

We observed that many teachers initially felt guilty about using DTP themselves i.e. keeping the resource outside of the classroom. DTP was in the early stages conceived as an an extension of word processing. This meant that to some teachers it was a just a better "white paper" resource.

Others soon realised just how powerful a full feature DTP facility was in terms of developing teaching materials when this included scanners and video frame grabbers. We can conject that the motivation for teachers to use DTP arises from their inherent reluctance to use materials prepared by others. All teachers like to control the development and use of learning materials for their own pupils.

In spite of the variety of typestyles and associated fonts supported by the more dominant DTP packages, many teachers perceived that none were ideal for early school. This was thought to be most important in the very early years where normally pupils are faced with the problem of learning to write in a particular script, yet their reading and other conventionally printed instructions are in a different form. Thus most children are taught to write a letter "ɑ" whereas most typestyles print a letter "a".

We have modified laser printer fonts to produce an "early school" font that enables teachers to develop printed materials representing the particular reading and writing fonts used at the early grades. This includes very faint/dotted letters and digits that children can trace and write over. Similarly, we have produced facilities for high quality printing in non-Roman character sets so that dual language texts can be produced in for instance Bengali, Gujarati, Hindi and Punjabi. We have achieved the production of the fonts by the slow and painstaking editing at the bit level of raster image fonts. Our longer term aim is to produce equivalent postscript stroke fonts.

Our co-workers have undertaken a major study on the effects of layout and typestyles on the readibility and legibility of teaching material. The preliminary findings are surprising in that typestyles appear to have little or no correlation with learning efficiency yet teachers perceive that they are strongly correlated. Thus teachers may be unnecessarily devoting time and effort to designing materials in a particular form. However, what is important is that teachers can generate materials in the form that they want and because they are in control of the design are strongly motivated to think about what they are producing and are strongly motivated so to do. This may out weigh any other reason for using the technology.

Not all teachers have the time, capacity or motivation to learn the intracies of full DTP and may require materials to be produced by a helper. We observed that it was generally unsatisfactory for teachers to specify to a DTP (computer based) technician what they wanted. Where the DTP technician was a teacher (perhaps seconded to a teachers' resource centre), there was very much easier communication and good quality materials produced easily and readily.

These same issues apply to our other co-workers who are developing materials for adult literacy which can begin to meet genuine needs. Thus instead of giving adults with poor literacy children's reading books, we can capture instructions on the labels of medicines, soap powders, airline timetables and other such real day-to-day communications.

b) In the classroom

Many instances were given by teachers of pupils preparing newspapers, magazines, posters and notices. These applications in the main were only an extension of word proceeding and all too often children were being encouraged to produce highly corrected text on paper before having access to keyboard.

Significant potential exists to enhance pupils' concept attainment by enabling them to organise and to structure knowledge by manipulating the presentation of textual and image. In particular, more rapid and explicit relationship between symbolic and iconic represenation is facilitated by exploiting the resources of DTP.

It is probably necessary for teachers to learn DTP by such applications because these are within their existing paedagogic framework. However, teachers who have explored writing processes, drafting and editing script are more quickly able to conceive new applications and learning ends that can be achieved. It is to be noted that most of the manuals that are designed to train users in DTP are directed at executing the DTP package and do not include training on design, typography and layout. Most users of DTP appear unaware of the basic principles of golden rectangles and focal points. We are currently developing an expert system based on XI-Plus that can be consulted for design advice.

c) extension of the media studies curriculum

DTP is more than text and therefore offers the opportunity to operate upon text and images and to explore the significance of each and the relationship(s) between them. DTP therefore becomes a most powerful means of involving pupils in the examination of communication, of meaning and of sign, and of the social construction and production of knowledge.

One example was the preparation of the front page of a newspaper in several layouts. Each had identical text but the emphasis and position of each news item and its relationship to images was different. Pupils were able to analyse their subjective impressions and to confront questions of power, merchandising and communication. This forms as useful precursor to the traditional lesson involving comparing different newspaper coverage of the same national events.

d) Quality communcation systems

In the U.K. particularly, current environmental and political influences are making schools more aware of the need to communicate with their customers i.e. school board, governing bodies, parents and to local and national government.

DTP is as one vehicle whereby this can be achieved since it facilitates readily produced high quality communication. Because of the increasing need to become market orientated, schools can seize upon DTP as means of developing their corporate image. Thus all their assessment forms and profiling as well as external communications, can have a house style. Whilst this use of the technology has been widely recognised, it has not yet been widely adopted in other than fee paying schools.

Conclusion

DTP is already well established in further and higher education and we can expect it to pervade all areas of education and educational administration. Expected benefits should derive not only from cost-efficiency but also by developing materials that can achieve learning ends not possible without the technology.

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PC STYLE CHECKERS - ROSES OR THORNS

Dr. Barbara J. Clinton*

ABSTRACT

Written communication is one way we share with others our dreams, our ideas, our destiny. Resources which can help us clearly express our thoughts in writing are of great interest to students, instructors and others who are responsible for creating corporate documents. Microcomputer application programs for writers range from off-the-shelf, one purpose packages, such as a spell checker and thesaurus, to style checkers, to sophisticated, partially developed, special purpose programs with AI components, such as M.U.S.E.[1] and C.S.I.L.E.[2] The programs in the first category which include the spell checker and thesaurus are already being embedded in many basic word processing programs. The following article discusses the writing tool resources of the second category,the style checker. The types of notations generated by three major style checker programs are compared with notations made by human revisors. Also, the results of "checking a paragraph" by the three style checker programs and a human revisor are reported. Finally, the development of an extended writing tool is encouraged.

INTRODUCTION

Students want them, corporations want them, state agencies and colleges want them. The "them" in question is a fast growing genre of software called style checkers. Style checkers are described as programs designed "to help a person improve his writing skills." Although plagued with a rocky beginning which included "vaporware" promises, these "software tools for writers" are gradually beginning to provide some valuable, though limited, editing features.

CATEGORIES OF COMPOSITION ELEMENTS

What type of information is one seeking when giving a colleague a document to critique? What is the purpose of rereading a document just written? Why does one revise or edit a written work? Answers to these questions can usually be grouped along a continuum which starts with a category of strictly lexical items, moves to categories of items concerning clarity and organization, and ends with a category of items about the inherent value of the information presented. Handout 1 shows the most common responses given by seventy-five Business Communication teachers from 30 school systems enrolled in courses at Georgia College during 1987-88. The teachers gave these answers when they were asked, "What composition elements would you want an editor to consider while reviewing your written work?".

A critique ignoring any one of these four categories is considered incomplete and of limited value. Therefore, persons asked to critique a document are chosen with great care. This is especially true as the perceived value of the information in the document increases. In most organizations persons with recongnized editing expertise can gain added prestige, and often are in a position to barter this skill for services or rewards from colleagues and the administration.

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HUMAN EDITORS VS SOFTWARE EDITORS

Human editors usually do not work from a given list of items to check or highlight.[3] After asking, 'What is the purpose of the document,' the human editor begins the critique. He first reads the document (a short document straight through, a longer document with some marginal notes as preliminary reminders) and then rereads the document marking individual words or sections. The identification of items in the first two categories (misspellings and grammatically weak sentence structures) by the human editor is constant, based on the personal knowledge and background of the revisor. The purpose of the document, i.e. instruction, annual report, corporate mission, on the other hand, recalls a specific list of checks for the editor in the third and fourth categories which include clarity of ideas presented, and the perceived value of the information.[4]

Although some recognized editors have had specialized post-secondary training many skilled editors appear to have a natural ability to note misspellings or mistakes in grammar. The later when asked, tend to make comments such as, "I have always been a good speller," or "The difference in use between lie and lay is very clear to me." Judgement about the clarity of ideas and the value of the information presented seems to depend on the problem solving skills of the editor, especially in the first step of problem solving: problem formation and identification.[5] Comments of the revisors about items in categories three and four vary from general statements: "This section does not make sense," to specific statements: "You mention a dual purpose but only give supporting facts for one."

In rating comments of editors, authors cite remarks of a lexical nature as important, but note that comments concerning the clarity of ideas and the value of the information more helpful to the writer in improving the quality of a document.

STYLE CHECKERS

Three microcomputer style checkers: Rightwriter by Rightsoft,[6] "Punctuation" + Style by Oasis Systems[7] and PC Style[8], shareware, by Jim Button state that the aim of their programs is "to help the user produce clear, powerful business and technical documents."

All three programs deal with lexical items in relationship to sentence structures. The packages do not provide spelling checks though Rightwriter generates a list of words which are not part of its vocabulary and suggests that the writer check the list for colloquial words, jargon, misspellings, misused words or words which the writer may not understand. Some items in Category Three concerning clarity of ideas, are lambently addressed by Rightwriter and "Punctuation" and Style with notations of "wordy phrases" or "the use of slang". Most items in categories three and four which include logical development of ideas and inherent value of the information presented are not addressed.

COMPARISON OF STYLE CHECKER FINDINGS

The paragraph chosen for a sample critique was written by a person as part of a selfimprovement exercise. The first paragraph (handout 2) was the original version and the second paragraph (handout 3) is the first revision of the original by the person. This revision was done sixty minutes after the original writing and was motivated only by the person being asked "to look over the document and perhaps make some changes that would tighten up the writing and express more clearly your thoughts." The critiques by the style checkers and the human editor are presented in handouts 4,5,6,7.

Evaluations by 200 students enrolled in the Introduction to Microcomputers course between 1986 and 1988 at Georgia College indicate that critiques by the three style checkers are "interesting" but not motivating or helpful in revision of documents. The same students found written comments by human editors good as a starting point for revision, but went a step further to specify oral comments as the most beneficial. The students felt human editors were more elaborate in their comments,and that a discussion was possible with the human editor. These students also stated that after they received the comments, a writing lab time with a human editor present usually guaranteed a motivated attempt to improve the quality of the written document.

However, do these findings mean that style checkers are not useful or that only human editors can help in meaningful revision of documents? No. The fact that persons are willing to try style checkers even before an available human editor, indicates that people would like to keep control of their document during the first stage of the revision process.[9] The students reported that a private beginning attempt at revision using a software program was more desireable than conferring with another person in identifying and correcting weak areas for first revisions. Once the document is revised in terms of misspellings and weak sentence structures the author is then more willing to seek feedback from a human editor in terms of viewpoint agreement and logical development of ideas. The issue is not if style checkers are valuable or have a place in helping persons edit their written documents, the issue concerns the ultimate goal and objective of using writing tools.

THE PURPOSE OF STYLE CHECKERS

If the goal of using a writing tool is to develop and improve a writer's communication skills then a spelling checker, a thesaurus and a style checker are only a few of the tools in a large tool box which the writer could use. Handouts 8,9 and 10 give an example of a model of an extended writing tool.

Written communication is one of the ways we share with others our dreams, our ideas, and our destiny. Resources which can help us clearly express our thoughts in writing will always be actively sought. The current style checkers are becoming effective tools which we can add to the spelling checker and thesaurus as embedded parts of word processing packages. Let us not stop with just tools of a lexical nature though, let us continue across the continuum and develop tools which will help us to further clarify our ideas and communicate our dreams. These are the software tools for writers worthy of the 21st Century.

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(Handout 2) THE PURPOSE OF LIFE

Many times we are asked the purpose of life. Oh no, I don't mean literally asked the question. But sometimes in a situation, things come up that make us know this is the real question. How do we respond? Well I will tell you how I would respond. The purpose of life is to recognize God as our creator and that we have to show love to our fellow man. Now I know that many people do not believe in God, evolution is purported to be how everything got started, my comment to that is if things got started with evolution and we evolved from animals why do we still have monkeys, why haven't they all evolved into humans, and why haven't humans evolved into something else?

(Handout 3) THE PURPOSE OF LIFE

Many time we are asked the purpose of life. The question may not be a literal or direct one, but rather certain situations lead us to believe that this is the real issue. In pondering the question I find my belief as to the purpose of life involves two things: The first is that the human race is indebted to a supreme creator, the second is that we are under obligation to love our fellow man. In regard to the first thought concerning the purpose of life, if anyone were asked who built a certain house and an answer was given that said the house just appeared or happened, it would not be accepted. The questionner would respond that things that are organized and have a purpose don't occur without an intelligent designer. How much more so would this hold true in matters as large, complex and regulated as the universe or as minute, detailed and eclectic as DNA?

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'VOCAPUCES' : Learning French à la Carte.

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ABSTRACT

Within the scope of two IBM Study Contracts, the research team of prof. dr. W. Decoo (Antwerp University, Belgium) has developed courseware materials for foreign language learning. This paper will outline the characteristics of one of those CALL packages: VOCAPUCES.

OBJECTIVES OF THE PROGRAM

Vocapuces is a program for introducing and training, in a contextualized way, a basic **French vocabulary** (more than 5000 items, source language: English). The program is aimed at the first 3 to 4 years of learning French as a foreign language. It can be extremely useful in higher levels too, especially for rehearsal and refinement purposes. Vocapuces can be used both at secondary-school level, and in adult education.

Since Vocapuces works with a selection system on data banks, the boundaries of the presented subject matter can be precisely adjusted to the needs of every individual user. You can go through the subject matter chronologically, according to specific semantic fields or word classes, always in the precise format desired. This is what we label as 'external versatility'.

EXTERNAL VERSATILE COURSEWARE

A traditional distinction is often made between "open" and "closed" courseware. "**Open courseware**" is understood then as authoring systems and authoring languages, which offer frames allowing the input of any material, thus giving a lot of freedom to the user but also asking for more work. "**Closed courseware**" is viewed as already tailored material, put into fixed lessons which do not require any work in setting up but which have a compelling content.

Vocapuces, however, presents a different system, combining the advantages of both the open and the closed courseware: a **selection system** on extensive content bases. The user still has the freedom to determine his own content materials, but it requires from him less than one minute of easy work.

Indeed, in courseware production one of the most crucial capabilities of the computer is often neglected: the power of immediate selection and combination from databases. For a large part of linguistic material, the computer is able to select and to combine precise elements from a wider corpus at will and in a matter of seconds, so that this selection matches precisely the initial situation and needs of particular students.

The principle of a selection system is simple: a maximal learning content is stored in a content base within the program. A **menu-driven** selection system allows the teacher (or the student if so desired) to select precisely those elements that are to be studied and practised according to a specific learning situation or learning need. Any elements that are not to appear in this situation can thus be discarded. The selected elements are automatically placed in the didactic frame of the courseware, which itself can be manipulated in variety of strategies.

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A menu-driven selection system on extensive content bases will result in **externally versatile** courseware: programs that can easily and rapidly be adapted to all external situations in which it is used. One and the same program should, given its extensive content base and the diversified access by a selection system, serve the needs of both the lower-intermediate high school student and the businessman whose French is on the upper-intermediate level but who wants to quickly refresh his hotel and transport French as a preparation for his business trip to Paris.

In the following sections we will outline the various aspects which make Vocapuces an externally versatile program: its content base, the 3 selection entries (chronological, grammatical and thematic) and the variety of exercises offered to the user.

CONTENTS

The lexical file of Vocapuces draws from two sources, on the one hand the older "**Le Français Fondamental**" of Gougenheim, which is based on frequency counts, and on the other hand the more recent "**Le Niveau-Seuil**" of the Council of Europe, which is based on semantic fields and which includes words selected on their degree of utility, i.e. items that you are likely to need in everyday foreign language situations. As such the final file avoids the classical trap with frequency lists where you will search in vain for items like 'une cuiller', 'une chambre individuelle' or 'un billet d'aller et retour'. Very concrete and practical items indeed turn out to be not that frequent. However in everyday situations abroad you will need exactly these items in order to be able to order your meals, to book your hotel and to organize your transport. It is by combining the two types of vocabulary lists that Vocapuces offers the user a well-considered balance between high frequency and utility items.

The chronological bias of frequency lists is evaded by keeping out words that in time have become less frequent and replacing them by highly current words, such as 'micro-ordinateur', 'astronaute', 'traitement de texte', 'navette spatiale', etc.

CHRONOLOGICAL ENTRY

Vocapuces can be used in a 'chronological' order by a beginner who still has to learn most of the vocabulary. The entire database is divided into 4 levels, each level includes between 1000 and 1500 items of French as a foreign language. These levels are further subdivided in chapters and **lesson-units** of about 50 items each so that beginners can go through the entire database in a classical lesson by lesson way. The order of the items is determined by their frequency value: as a rule the more frequent items come first.

Apart from the opportunity it offers to go through the entire content base in a lesson by lesson way, a major advantage of this chronological organization of the content base is that it constitutes an overall **level indication** of the included vocabulary. A beginner can for instance combine a semantic selection (eg. furniture) with a level 1 indication. In this way, he will only get the more frequent or basic pieces of furniture, i.e. those which are included within the range of the 1000 most frequent words in French.

GRAMMATICAL ENTRY

The user can also concentrate on a certain **word class**, or a combination of these. The word classes are divided traditionally: nouns, adjectives, pronouns, verbs, adverbs, prepositions, and conjunctions. To these we also added expressions. Any combination of these is also possible. As such a user can focus on grammatical problems as for instance the typical French syntagm of a verb followed by a preposition and the infinitive (eg. apprendre à, dire de, ...).

THEMATIC ENTRY

The real richness of the program is situated in the possibility of studying the material thematically. The more than 5000 items are divided into 193 semantic fields and subfields, largely matching the "general notions" and "specific notions" of the "Niveau-Seuil".

Because of the ergonomic selection system, the user can ask for any field or subfield or a combination of fields. So if you are planning a business trip to Paris and you need to brush up your hotel, restaurant and taxi French you can quickly select the menu 'eating and drinking' combined with 'going somewhere', and in both menus you will find several useful submenus (means of transport, traveling abroad, restaurant, etc.), allowing you to precisely define the vocabulary you will need.

COMBINABILITY OF ENTRIES

It is obviously possible to combine all three above mentioned criteria and to select for instance:

- A chronological approach combined with a thematic limitation (part of a revision at a certain level from a semantic point of view):
    - * All the items at beginner's level about "food".
    - * All the items of the lower-intermediate level about expression of "quality".
- A thematic approach combined with a grammatical limitation (focus on specific lexical needs or problems):
    - * The adverbs of time.
    - * The prepositions of place.
    - * The adjectives expressing colour.

It is clear that any user can in this way tailor the content base exactly to his own specific needs and/or learning situation.

A DIVERSITY OF STRATEGIES

Any selection made, using the above mentioned entries, can be trained in a variety of exercises. Users can select gab exercises with or without hint, translation exercises from source to target language and the other way round, multiple choice exercises, ... All exercises offer features as on-line help routines, automatic typing error correction, optional time limit setting, etc.

MULTIPLE ENVIRONMENT MODEL

One and the same program must be able to operate in various environments. For one thing, it should be possible to use the program in both individual and teacher assisted learning environments. It is therefore users can work with Vocapuces in three different environments, all having their specific characteristics and features adapted to the working situations they were designed for:

A LA CARTE

"A la carte" is a typical environment for the more advanced user. This environment opens all the menus for the user who himself can adjust contents and strategies at will. He can do so by going through a series of convenient menus which appear in overlapping frames on the computer screen. This way he can choose particular lessons and/or particular semantic fields, and/or particular parts of speech. Next he can select the strategies wanted by using similar menus: presentation, exercises or test. Any combination is possible. The selection system allows the definition of any precise didactic unit.

PLAT DU JOUR

"Plat du jour" is meant for users who need **more external guidance**, or who must work according to a very precise learning scheme. It offers the user a precise content which was defined in advance by a particular teacher or tutor.

"Plat du jour" avoids that the student must make selections himself. Indeed, in most cases students will have to work on vocabulary in direct relation to the material the teacher wants them to learn or to review. The student will simply select "Plat du jour" and he will receive an overview of the lessons available, organized according to the teachers using the program, according to the various classes of each teacher, and according to the specific lessons planned for each class. A simple three times 'enter' will do for the selection of a unit in 'Plat du jour'.

As soon as the student has selected his unit, it is composed from the database in a fraction of a second, exactly as the teacher has predefined it through using the separate teacher's entry.

The **teacher's entry** is meant to quickly define and store on disk the exact content for a particular class or student. It is in other words the way for a teacher to organize and prepare lessons in the "plat du jour".

The same menus as in "à la carte" allow a teacher to define the unit. It takes an average of 20 seconds to do this, since the teacher does not have to type anything, he has only to indicate the precise limits within the potential and to determine the strategies he thinks appropriate for the contents and the target public selected. The units thus defined and stored on disk can be changed, expanded or erased whenever the teacher wants to.

DIGESTIF

A third environment is called 'digestif'. Here a student will, after working in 'plat du jour' or 'à la carte', find his **remedial material**. That is to say, during his work the program keeps track of all the mistakes being made and it enters them in the 'digestif' environment. Students can first have a look at their mistakes, study them again and start a new exercise on the restricted subject matter.

CONCLUSIONS

Vocapuces belongs to a new category of courseware which is neither open or closed: it precisely meets the needs and demands of a large target public by combining an extensive and well-founded linguistic content base with an easy to handle menu system. As such users can both at the content and exercise level select the material which most closely fits their own individual needs. Given its multiple environment design, the program can be implemented in both individual and teacher guided learning environments.

USING COMPUTERS TO PROMOTED INTERDISCIPLINARY WRITING ACTIVITY

V.E. Baer

ABSTRACT

In an innovative, two-year project, the faculty and students at Boonsboro Middle School in Washington County, Maryland used computers successfully to integrate writing activities into most content areas of the curriculum.

Faculty members participated in workshops which stressed: 1) components of the writing process, 2) the importance of writing in the content area, 3) development of content area writing activities, and 4) using computers to implement writing activity. Participants had access to a networked laboratory containing thirty-two computers equipped with keyboarding and word processing programs.

All 560 students spent six weeks (two half-hour sessions per week) learning basic keyboarding skills (Typing Tutor III). Then they spent four more weeks learning the basic operations of the word processing program to be used for their assignments (SRA Writer for year 1; Writing Assistant with spell check feature for year 2). This initial instruction prepared students to compose, edit, and revise content area writing assignments on computer.

For the remainder of each school year, content teachers from such areas as social studies, science, math, language arts, music, and art scheduled time in the computer lab for writing assignments. Often, teachers prepared their classes in advance with the topic of the assignment, an initial prewriting activity, and directions for completion. Encyclopedias, atlases, almanacs, and dictionaries housed in the lab provided easily accessible reference materials for students as they composed at their keyboards. Eventually, students initiated computerized information searches with a CD-ROM station using Grolier's Electronic Encyclopedia and a printer.

Students were enthusiastic about participating in computerized writing activities. Editing and revising became simple tasks; printouts looked professional; and keyboards reminded some students of necessary punctuation marks. By the end of the pilot project's second year, 75% of the school's faculty were using computers to do written assignments with their classes. Over 50% scheduled computer-facilitated writing assignments on a regular basis.

New Mexico State University

TECHNOLOGY EDUCATION WITHIN TEACHER EDUCATION

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ABSTRACT

This paper discusses experiences in teacher education in which computer literacy is cast within the broader definition of technology education. These experiences operationalize the emerging definition of "technology education" as it relates both to the education of elementary or primary children and to the education of their teachers. This embedding of computer education within technology education facilitates teachers accepting technology education as both content in their teaching practice and as a means through which children acquire computer skills in the context of confronting problem-solving tasks related to our technological society. Specifically, this paper outlines how one teacher-education program is beginning to address the need to develop technology education and computer education so that they are integrated with the rest of the curriculum and thus able to help children develop a sense of what technology encompasses and the role of computers as a tool within this context.

INTRODUCTION

The evolving technology education component of the elementary or primary level teacher-education program at the University of North Florida rests on three key assumptions. First, we believe that preservice teachers' understanding of technology education is best developed when concepts and skills are infused into appropriate experiences in related courses in the program. Technology education provides both a content area for children's learning experiences and the means through which appropriate tools are used in order to address meaningful problem-solving tasks which they encounter. Second, our definition of technology education encompasses the computer as a tool. Computer education is therefore seen as a means to effective learning rather than an end unto itself. Third, the many uses of the computer and other technological tools serve to facilitate children's thinking as they develop their abilities to understand and analyze information about technology and investigate and solve problems which either simulate problems in the larger society or function as applications of information. As a result, the content areas assume a sense of relevance to the children.

Moreover, technology education as a content area includes study of topics which both integrate knowledge from other subjects in the curriculum and provide meaningful contexts for the development of critical thinking processes and problem-solving abilities. Some of these broad topic areas include construction, manufacturing,production of energy, transportation, and communication, along with the environmental and biological aspects of these topics. These topics which are familiar to the elementary or primary curriculum acquire new meaning as they are related to technological concepts and generalizations and as they are supported by skill development using appropriate technological tools. The richness of

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these topics also allows for wide exploration of knowledge and for consideration of varied problems with relevancy to everyday life.

Through the consideration of these areas, preservice teachers may experience the issues children will address in their own learning. Thus, the technology education component of the elementary or primary teacher education program has students both experience the activities children might follow and reflect on how those activities facilitate learning and how they might be designed.

EXAMPLES OF PROMOTING TECHNOLOGY EDUCATION

It often seems best to augment an account of the general attributes of an educational program through the description of specific examples of learning experiences offered to program participants. While these are only examples of how technology education and computer education are communicated to students, they do indicate how these components are incorporated into the teacher education curriculum at the University of North Florida.

The importance of the relationship between the problem-solving process and the use of technological tools to facilitate that process cannot be overstated. The power of appropriate technology becomes evident when problems are identified, strategies to address these problems are selected, plans are implemented, and possible solutions are reflected upon for accuracy, feasibility, methodology, and impact. The inclusion of technological tools as integral components of children's problem-solving processes is introduced in the context of science, mathematics, social studies, and art methodology courses in the undergraduate program.

The following examples represent a very small sample of the activities available to our students; in addition, they are encouraged to think beyond these applications. Simulation programs such as cross-country travel, or the operation of a hot-dog or lemonade stand, as well as conducting scientific experiments are applicable at all steps of the problem-solving process. CAD (computer-assisted design) programs are used in the initial phase of designing prototypes that may eventually be put into production. Desktop publishing integrates journalism skills and graphic design to result in a powerful vehicle for information dissemination via a classroom or school newsletter. The use of tutorial programs and existing data-bases enable retrieval of information and lead to better and more informed decision-making. Knowledge of electronic communication devices and their capabilities is also addressed. The use of spreadsheets for hypothesis testing, financial projections, and simulations as a teacher utility is heavily relied upon in the science and mathematics classes. The implications of robotics on manufacturing, construction, and society are also explored.

A second example of how technology education is incorporated into the teacher education curriculum occurs well along in the program of study for a bachelor's degree in elementary education. "Integrated Learning Environments" is a course which encourages students to think broadly about curricular issues in the context of professional decision-making. Students also explore techniques for integrating content areas while delivering instruction to elementary school children. Because the integration of the content areas of the curriculum may often be an abstract concept for preservice teachers, topics or themes related to technology education clarify how the traditional curriculum areas support each other.

For instance, a learning center developed around the theme of photography may incorporate scientific principles, focus attention on the medium as a form of communication, or consider its place in recent history. As such, the theme becomes a vehicle for addressing concepts in several curriculum content areas. In addition, it provides an opportunity for children to examine a technological tool which has also been enhanced by computer applications which in turn may affect its future development. The careful selection of topics or themes allows children both to experience learning activities across disciplines and to acquire generalizations about our technological society which by necessity use information from more than one content area. Basic skills and familiarity with the tools of modern life are kept in context as children study topics of interest and concern to them and society.

Such an approach to curriculum topics or themes requires a commitment to using hands-on experiences as starting points for children's learning. The almost natural connection between technological topics and everyday life in developed societies makes experientially based education a logical outgrowth for many of the learning activities which teachers can design for children. When justified by developmental theory in psychology and with the rationale of engaging children's interests through active learning, experiential education becomes an essential strand within technology education. Furthermore, with hands-on experiences related to everyday life, complex ideas from specific content areas become more meaningful to children and the development of skills in using technological tools becomes easier to foster.

The "Integrated Learning Environments" course stresses that a process orientation is also a significant strand within technology education. As preservice teachers consider technologically related topics or themes for study, they identify questions and problems which children might investigate related to those topics. In the course of such investigations children will practice and enhance their abilities to think critically, to observe carefully, to organize information, to make decisions, and to solve problems. Since all of these processes are central to effective living in the modern world, emphasis on them in the elementary or primary curriculum is highly appropriate.

In the course of examining how to integrate content areas, provide for hands-on experiences, and encourage the development of processes, preservice teachers engage in learning experiences that children might encounter as well as practice teaching activities which they can implement in the classroom. To these ends, they experiment in the Technology Education Workroom. This hands-on laboratory provides the setting and the materials for analyzing the information base for technology education, its integral connection to the rest of the curriculum, and the central role of various technological tools in operationalizing technology education. They use this facility to demonstrate how they might respond to the challenges of teaching the concepts and skills related to technology education.

FUTURE DEVELOPMENTS

The outcomes of these efforts at the University of North Florida affect both preservice teachers and the future classes of these teachers. While the infusion of technology education into the teacher preparation curriculum is not yet complete at this point in time, our efforts to conceptualize the nature of this infusion have yielded significant changes in the mathematics, science, social studies, and art methodology courses. In addition, the "Integrated Learning Environments" course has become the vehicle which enables students to integrate the various methodologies, process education, critical thinking, and problem-solving, and use technological components to support the curriculum.

Such a response can only strengthen the education of preservice teachers and subsequently the instruction they offer to their own classes. Much remains to be done in terms of including additional methodology courses in the effort, more fully defining the nature of technology education for thinking and working in the twenty-first century, and most importantly, describing in more detail how teachers actually do develop children's abilities to investigate and solve problems, to think critically, and to select and use technological tools. Yet, the education profession can hope for no more suitable a goal than the development of teachers who can encourage children to think clearly and carefully, to solve the problems they face effectively, and to select appropriate technological tools to support their efforts.

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TEACHING MICROCOMPUTER APPLICATIONS

M. C. Yopp

ABSTRACT

Microcomputer Applications--word processing, spreadsheets, data base management systems and graphics--are useful tools for teachers in any discipline. They are essential tools for business education teachers and most vocational education teachers. There are a variety of software packages available which require a variety of hardware configurations. Several of the most popular software packages will be presented along with a brief description of hardware requirements, capabilities, and projections for the future.

INTRODUCTION

This paper presents information for teacher educators about software packages readily available to assist with the teaching of microcomputer applications. I have been teaching word processing, spreadsheets, and database management since 1982. I first taught computer applications using Radio Shack TRS-80's and compared with typewriters, I thought I was in heaven and my students thought so too. They loved Scripsit, Visi-Calc, and Profile III+. Less than six years later, I have migrated through SuperScripsit, WordStar, SuperCalc 3, dBase II, dBase III, dBase III+, Microsoft Word, WordPerfect 4.2, WordPerfect 5.0, Lotus 1,2,3, Visual Planner, and Microsoft Works.

Technology is moving so rapidly that it is difficult to stay close behind, let alone catch up. I have devoted countless hours learning these software packages and developing materials to help teach them to students as quickly as possible. Text materials often lag behind software development and they are expensive. Therefore, students in my program and I have worked together to develop tutorials to introduce students to each new software package and provide them with a reference they can use and keep which is not copy protected, which can and is updated frequently, and which can be photocopied and given to students. Teachers from all over Washington State and Idaho are using these tutorials in their classrooms effectively.

The tutorials are not always perfect the first time we use them. They do not have to be. I encourage the students to critique the explanations and suggest improvements. We then go back to the narrative and make changes. Some of the tutorials are very brief and designed to provide students with an overview of the package before learning the specifics. This has worked well for us. Copies of tutorials are available for photocopying and postage costs.

I use educational software packages almost exclusively. These are provided by textbook companies when you purchase a text. The software has a few limitations but not many when compared to the investment

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necessary to purchase 20 or more copies of the complete version when you know something new will be coming out shortly. We have purchased a site license to use multiple copies of WordPerfect 4.2, WordPerfect 5.0, and Microsoft Word. The educational version of WordPerfect is acceptable for teaching beginning applications but does have considerable limitations. The WordPerfect Corporation will issue site licenses for 5.0 to educational institutions for under $50 each when purchased in multiples of ten.

HARDWARE REQUIREMENTS

Hardware requirements and compatibility are the two most important considerations when choosing software. The TRS-80 lab I used quite effectively had 20 computers each with 32K memory networked to a Daisy Wheel letter quality printer. Any limitations seemed minimal and, if necessary, I could still teach students a great deal about computers and microcomputer applications using that equipment. Teaching students something about word processing, spreadsheets, and data base management is better than teaching nothing about these tools. I advocate teaching the best you can with the equipment available and move forward at a steady rate. Most of us are not going to be able to upgrade our entire labs at one time. Rotate students on and off of the more advanced equipment and software as it becomes available. Encourage students to anticipate and accept change.

In the Fall of 1986 the lab I use was equipped with 20 MSDOS computers with 256K, monochrome monitors, and Epson FX-85 near letter quality printers. Again I thought I was in heaven and eagerly began teaching WordStar, SuperCalc 3, and dBase III. I used educational software with a minimum of difficulty but the supporting text would not stand alone. Some sections were too detailed, others were too brief or not clear, control keys were presented in an illogical order. I had to prepare a considerable amount of supplementary explanations and exercises. These were later expanded into tutorials.

By January of 1989, we have upgraded 10 computers to 640K with graphics cards. We have one PC with a hard drive and a color monitor, a second PC has a color monitor, we own one PS/2 Model 25, and two PS/2 Model 30's with hard drives and color monitors. All of the computers are still using Epson FX 85 printers, and we own a Sharp projector which allows the instructor to project the image on the computer onto a screen using an overhead projector. If twice before I thought I was in heaven why don't I feel that way now?

Most of the computers in the lab will not operate the new sophisticated software packages. I have 10 computers which will operate WordPerfect 4.2, Visual Planner, and dBase III+. They will not operate Microsoft Word, Microsoft Works, or WordPerfect 5.0. The double disk drive monochrome computers with 640K will operate Microsoft Word but they do not work well with WordPerfect 5.0 or Microsoft Works, an integrated package. This reduces the number of computers I have to do the most modern applications to four. Since I have 18 to 20 students per class I will have to rotate students and schedule a number of additional labs to accommodate the demand. I have written proposals to fund additional equipment but I know it will come in bits and pieces. This means I have to individualize my materials and teaching methods even more than before. I will continue to teach the best computer applications I can with the equipment available but it will require considerably more classroom and lab management.

SOFTWARE SPECIFICS

WordPerfect 4.2 is still an excellent program for teachers and students. Hardware requirements include MSDOS, 256K, a monochrome monitor, and any compatible printer. WordPerfect 4.2 is a workhorse. It can easily be used for letters, manuscripts, and other business correspondence. It can also be used to teach students and teachers what to expect when converting to WordPerfect 5.0. Most of the function keys are the same. Moving from WordPerfect 4.2 to 5.0 is relatively easy. WordPerfect 4.2 has an excellent spell check and thesaurus although these do not come with the educational version provided by publishers. It will automatically insert footnotes or endnotes, it will arrange text in columns, it will automatically insert the date, it allows for double indenting of paragraphs, and it will mail merge letters and addresses. I think it still deserves a high evaluation.

WordPerfect 5.0 requires a minimum of 512K but 640K is recommended and it is designed to be used with a hard drive. The April, 1988 issue of The WordPerfectionist, a WordPerfect support group publication states:

> It is important that members realize that 5.0 demands much more from your computer than 4.2. We do not feel that one can effectively utilize 5.0 on a computer with only two 360K floppies. If you cannot afford to upgrade your system to a hard drive, we recommend that you stick with 4.2 until you can. A 20M hard drive today should cost around $300.
>
> WordPerfect 4.2 will be supported through 1990.

The advantages of WordPerfect 5.0 include graphics and desktop publishing characteristics which enable the user to increase and decrease the size and quality of the print or font. Some features will not respond properly if the user does not have a laser printer and additional fonts. Again hardware requirements dictate success in using software.

Because of the different font sizes, margins and tabs are set in inches instead of spaces and the format commands have been reconfigured. WordPefect 5.0 is too large to fit on one floppy disk. WordPerfect 5.0 will run on a local area network but it should have a dedicated file server. You do not have to have a color monitor or a graphics card to operate 5.0 but if you want to utilize all of the graphics and print features color graphics is desirable.

Microsoft Word 4.0 requires 320K memory but it will work satisfactorily with double disk drives. In 1988 Microsoft Word was the second most popular word processing package being purchased in the United States. WordPerfect was number one. Microsoft Word is available to educators at the special price of $350 for a site license for ten computers. This package comes with one set of documentation. Microsoft Corporation is working on a 5.0 version of Microsoft Word which is supposed to have graphics and desk top publishing capabilities like WordPerfect 5.0 but will certainly require additional hardware specifications.

Microsoft Works is an integrated package combining word processing, spreadsheets, and data base management with graphics, a communication capability, and a limited selection of font sizes. It is quite powerful and reasonably priced. I paid $89 for mine through the University of Idaho with an order sent directly to Microsoft. It is listed between $100 and $200 in computer software catalogs. Works requires a minimum of 384K and a graphics card. It will work with any MSDOS personal computer but works faster using a PS/2 system. It is quite user friendly but the spell check is not as good as those offered with WordPerfect and Microsoft Word. Microsoft Works is the best integrated package I've used in the classroom. The user can switch easily between applications, combine information, and present it in most any format without having to quit one tool and start another.

Lotus 1,2,3 operates with 256K but you must have graphics capability to do graphics. Teaching students to utilize spreadsheet functions is relatively easy once they understand with it is supposed to do. Entering formulas and functions and copying them expands the power. Spreadsheet design and analysis is more useful when students design their own spreadsheet and use it for some useful purpose like a gradebook, check register, or to design common business forms. Visual Planner, Twin, and Joe Spreadsheet are Lotus clones which come bundled with some microcomputer applications texts. They work just fine but do not do graphs. The student version of Lotus 1,2,3 is under $50. It shows graphs on the screen it you have a graphics card but it will not allow users to print the graphs.

dBase III+ and dBase IV are sophisticated relational database programs which have evolved from dBase II and dBase III. The educational version of dBase III+ is available with several of the application texts. Its only limitation is that the program only allows the user to manipulate 31 individual records within the database. For educational purposes this is acceptable. dBase III+ introduced the "assist" menu screens to supplement the dot commands used in the two earlier versions. dBase IV operates much the same as dBase III+ but has enhanced capabilites with other operating systems.

The software packages described here are those most widely used by business and industry which is important when preparing students for the world of work.

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Educational Computer Use: A Matter of Perspective

* Steve Biancaniello

Computer technology has provided opportunity for innovation to virtually the entire social structure. Evidence of this innovative process is quite visible in various areas of the society. The impact of computers on the stock market is an example. Computerized trading has become a catalyst in the growth of the market's activities. In medicine, computerized image enhancement and huge informational resources have revolutionized diagnosis. The retail business community has developed a variety of computerized functions including; automated accounting, inventory control systems, order processing and forecasting packages. These tools have provided invaluable information and unlimited capabilities to compete in the marketplace. Computerized banking has produced a revolutionary process to address community needs while simultaneously providing enormous flexibility on the part of the banking institutions to manipulate funds to increase profit. Computer Assisted Design (CAD) systems have reduced the the cost of producing architectural designs, and dramatically increased the potential to tap the creativity of the architect.

One key factor in the success of computer innovation in these areas has been the fact that computers have had a very defined role, clearly identified goals and a sophisticated support system. These elements accompanied by financial, organizational and attitudinal commitment, have produced clear and significant changes in most areas of our society.

However, in education computers have not experienced this level of success, especially at the K-12 level. Most schools are struggling in an environment of low confidence and budgetary cutbacks. Declining student performances, restricted resources and social pressure have put school districts on the defensive (Rogers, 1985).

An analysis of literature on this topic suggests that there is a difference in how teachers and administrators perceive computer use in classroom instruction. Consequently, the successful introduction of computers into curricula faces some difficult problems. Both administrators and teachers agree that the implementation of computers into instruction will strongly impact instruction. Computers alter classroom dynamics, and require teachers who are competent in their use, confident in their own ability to help students learn, and comfortable with the delivery system.

The premise of this paper is that the gap between expectation and reality regarding computer use in instruction, has its origin in the different perspective maintained by the two primary stakeholders in this process, administrators and teachers.

Administrators, as a group, have a set of assumptions with respect to computer use in instruction. They maintain that with minimal effort and the "right" software, the

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computer could be implemented into instruction (Bozeman, 1984). There is evidence of this perspective throughout the literature. Romaniyk (1983), Lacena (1984), NCTEA (1985). These studies identified administrative priorities, skills and proficiency levels for teachers. More specifically, administrators focused on making teachers comfortable with hardware and software. If quality software could be purchased; if curricular objectives could be met with the software; if lesson plans could be developed for teacher use; and if teachers could be trained in these lessons and procedures, then teachers would use computers and programs would be enriched. In essence, the administrators' position was one of producing programmatic "teacher proof" instructional activities to support curricula. There was little emphasis on the dynamics of classroom instruction or learning methodology.

Teachers, as a group also have a set of assumptions with respect to computer use in instruction. Donald Maley (1985) identified the foundation of these assumptions. Computer use must be proactive, questioning, interdisciplinary, and involve the learner. Computers must tap the creativity of both student and teacher. They must contribute to the transfer process of knowledge. What is needed, are devices to think with. Teachers are focused on instruction, resulting in emphasis being placed on the specific dynamics of teaching. This includes providing direction and assistance in developing instructional methods that integrate computers into the thinking process.

Futurists like Christopher Dede (1984) predicted effective educational futures with high computer use. He predicts desktop computers will create new types of instruction. Graphics, music , and voice output will enable computers to teach sophisticated skills. The computer, he says, will be able to diagnose the learning style of individuals and gear instruction to match these characteristics. With such sophisticated tools, students will be expected to master many types of information more rapidly than in present day classrooms. This vision of the classroom of the future establishes a model that educational planners are expected to implement. It also proposes a time line that reinforces the perceptions already held by administrators. The need to respond quickly.

Administrators needed to respond to the pressure from the community and the vendors. The teachers needed to respond to the needs of the students who were embracing this technology with enthusiasm and inquisitiveness. This is significant. The set of criteria needed to address different sources of pressure seems to have established different priorities. The sources of this pressure were not only varied between administrators and teachers but intense for both parties. Whether it is the cost factor, the novelty, the demonstrated impact on other areas of the society, or the perceived potential of the medium that causes this inordinate amount of pressure, the results seem dramatic on the process of computer use in the classroom. Administrators charged with the management of large technology budgets must respond to a constituency with programs that are visible, and effective. Communities have put a priority on computer programs. Subsequently, the priorities of administrators, the primary program planners, is on design of projects that respond with objective data demonstrating success rates of the program. Teachers, at the point of impact of these programs, the classroom, must respond to the expectations of the community to produce students skilled in computer use. Teachers are concerned less with what the program looks like to the community, and more on how it addresses the needs of the students. Regardless, the pressure is real and significant.

Administrators and teachers, relying on their information base, and reacting to their specific pressure points confronted the challenge of computer innovation in an environment that was quite different from the environment experienced in the areas of society mentioned earlier. In place of clearly defined roles and objectives there is a differentiated view of how teachers and administrators perceive computer use in classroom instruction. Administrators are focused on the program design resulting in emphasis being placed on the general dynamics of implementation. This includes providing the format for implementation and training with the tools to be used to implement. Teachers are focused on the instruction, resulting in emphasis being placed on the specific dynamics of teaching, and the use of computers in those dynamics. This includes providing direction and assistance in developing effective instructional activities using the computer. Administrators tend to focus on the format of programs using computers. Teachers focus on the processes of using computers in classroom dynamics.

The training of teachers and administrators in the effective use of computers in instruction is an essential part of any well developed computer instruction program.

An Arkansas, (1986) study identified a variety of in-service projects that resembled "cafeteria style" workshop sessions. Teachers chose among a host of workshops. Most of the offerings were designed to implement software into instruction through curricular objective lessons.

Cuban, (1986) cites a lack of adequate training of teachers as a major reason why computers are not used either daily or, in some cases, on any regular basis. The provision for training and better equipment is not enough. Training should be tailored to the classes of opinion and attitude that already exist in the school (Knupfer, 1987).

The 1986 Council of Great City Schools Report identified in-service programs among the largest urban school systems in the country. All district maintained an elaborate in-service structure. Software evaluation sessions, software training sessions, and harware/software informations sessions, were the predominate kinds of in-service provided.

Irene Rodriguez, (1985) identified a very structured program that provided 100 hours of instruction for all teachers. The results demonstrated inconsistencies. The teachers received significant training and reported that they were comfortable with the medium. However, use of the computers in the classroom was sporadic and limited.

As the most salient literature reveals, the computer's potential as a learning aid in the schools remains tenuous due to lack of firm evidence about its educational strengths and weaknesses. Further, the way that teachers implement the machines in daily practice will certainly influence the computer's educational impact (Knupfer, 1987). Terry Ciccheti (1984) demonstrated that teachers do indeed need to have computer literacy skills. However, their own concerns must be addressed as well. He also stated that training teachers is complex, and attention must be given to personal and systematic change.

In education, as in other systems, when we change one aspect of a system, other aspects are necessarily altered. Innovation, at any level or degree will affect the entire system. When we incorporate innovative instructional technology in schools, we alter the power relationships between student and teacher, among school personnel, and between the school and its environment (Perelman, 1988). The attempts to make these changes are founded in perspective.

There is reason to think that there may be difficulties ahead for teachers attempting to alter their classroom patterns to acommodate computers. If teachers do use computers in the way most of the training programs suggest, they face an erosion of their influence in the classroom. Teachers are interested and excited, for the most part, in the promise of the computer as a tool for instruction. However, to date they have not been able to implement its potential in the classroom effectively (Olsen, 1985).

Are we missing the mark in planning for computer use success? If so, why? It is clear that needs have been identified by both administrators and teachers. Curricular objectives were being met, new skills were being taught, computers were active in the instruction process, but the value of using computers to accomplish that was questioned by the teachers.

Planning models and goals have been established, but somewhere in the process outcomes and expectations have varied. The stakeholders have envisioned different concepts, and reacted differently to the needs identified by planning.

Computer technology provides a significant innovative opportunity. Frustration exists due to a lack of success in the innovative process. Pelz and Munsen (1980), identified "Core" aspects of innovation. were identified. Success was determined by examining how these aspects were active in the field. If this formula were to be applied to computer inovation it becomes evident that administrators and teachers have developed different "core" aspects. This created different agendas, and subsequently different expectations.

What are the proper roles of the computer vis a vis direct experience, and what do they imply for curricular design, teacher practice and teacher training, hardware and software design? The answer to these questions will provide insight into the perspective of administrators and teachers with respect to computer use.

USING HYPERCARD FOR RAPID PROTOTYPING OF AN AUTOMATED TRAINING SYSTEM

Doris K. Lidtke[**]

ABSTRACT

Hypercard provides training materials developers with a tool for rapid prototyping. Hypercard is easy to use, provides the training developer with excellent support and allows for modular development of training materials. With relatively little effort on the part of the developer, the functionality of the training system can be quickly developed and demonstrated. This allows the developer to obtain early reactions from potential users of the training system, to make modifications and retest without the tremendous expense of the development of a pilot training system.

One of the important things to learn about a training system is how the user employs the training system. With very little effort this system can monitor the path the user follows through the material, the responses of the user, and the amount of time the user spends on each segment of the material. Since the user is allowed to interrupt the training at any time to ask for definitions, clarification or help, the traces of user interaction with the system should give the developer much previously unavailable information that can be useful in improving the training materials.

INTRODUCTION

Since November 1987 when Hypercard became widely available, many users have used it to prepare materials for use in education and training. These materials vary widely in sophistication and utility. One of the major advantages of the Hypercard system for developing training materials is that the frames can be presented in an almost unlimited number of sequences. The sequencing can vary from a simple, set sequence determined by the developer to a complex calculation to determine the next frame to be presented based upon knowledge about the user, the material that the user has already used, and how the user interacted with the previously presented materials. With Hypercard the user can also interrupt any presentation to terminate a session, or employ any available, special

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options; for example, finding definitions, seeing examples, or testing to determine the degree of mastery of the material.

THE BASIC ATTRIBUTES

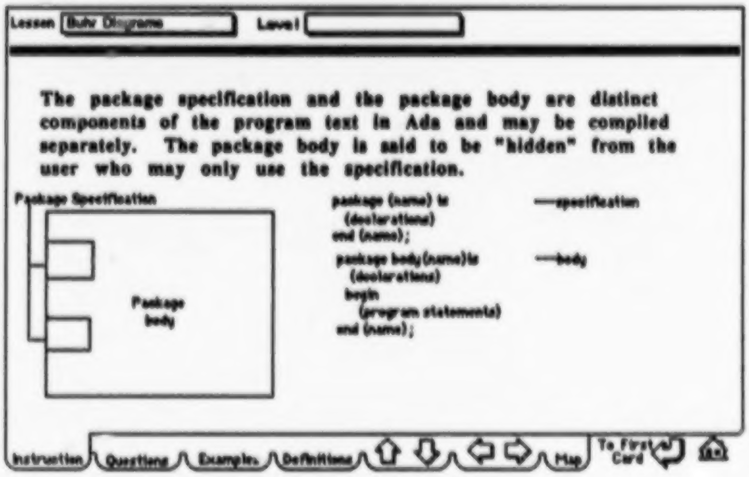
Hypercard allows the developer to prepare a series of cards [usually called screens or frames when developing Computer-Assisted-Instructional materials] to present to the user. These cards can be created quite quickly. They are relatively easy to prepare since each card presented to the user is composed of any one of the developers basic card backgrounds and as many "transparent" and/or "opaque" overlays as desired to form the card which will be displayed to the user.

Each card may contain text and drawings. Portions of a card may be designated to contain particular information. For text a scrolling window may be created to allow virtually unlimited text if the user chooses to scroll through the text. Drawings may be quite simple or complex depending upon the needs of the particular training material. One good example of the use of drawings is the introduction to the Macintosh SE which shows a sketch of the machine. The user may learn more about any part of the Mac SE, since clicking on any part will trigger the display of an expanded drawing of that element of the computer. To allow for quality artwork drawings may be imported into Hypercard.

Once the cards have been designed the order or orders of presentation must be determined. This can vary from presentation in a particular predetermined order with each card presented for a specified time -- this might be appropriate for an animated demonstration sequence -- to some elaborate calculation of which shall be the next card or cards. In addition to determination of presentation by the developer, each card may have a button or buttons which give some degree of control to the user. When the user moves the mouse onto a button and clicks the script or program which has been placed under the button is activated. The script may be very simple, for example, "go to next card," or a relatively long program which determines the next material to be presented.

EXAMPLE

The example below is taken from a prototype. The user will normally click on the arrow which points to the right. This will take the user to the next frame based upon a short program which uses the level of knowledge this user desires, the speed with which this user assimilates material, and the type of presentation preferred by this user. The time the user spends on this card will be recorded and become part of the record collected on each user each time the training material is used. Should the user decide to deviate from the developer planned presentation of the material the user may request any of the following: instruction, questions, examples, definitions, less detailed knowledge about this topic, more detailed knowledge about this topic, review of recently presented material (up to the last 42 cards presented), an opportunity to look at the overall organization of the training materials and choose the next section to explore, or to terminate this training session. See Figure A.



The package specification and the package body are distinct components of the program text in Ada and may be compiled separately. The package body is said to be "hidden" from the user who may only use the specification.

```
package (name) is                —specification
  (declarations)
end (name);
 package body(name)is            —body
   (declarations)
  begin
    (program statements)
 end (name);
```

Figure A

RAPID PROTOTYPE

Since the Hypercard system is very easy to begin to use, the training materials developer can design a short series of frames and have users react to the materials. A few frames will allow the user to react to the format of the frames, the content and the options available. In the example discussed above the instruction track was developed for users at two levels of learning, a few questions, a few examples and a few definitions were developed. This allowed users to try the material and comment on much of it very early in the development. The concept of allowing the user to request fewer or more details was demonstrated for only one frame. This needs to be expanded to give a more realistic trial to this concept. Since the idea of allowing the user to review recently presented material is so easily implemented in Hypercard and since this is a concept worth testing, it was included in the prototype. The idea of a map showing the overall organization of the training materials was included because of the many cautions in the literature that in the hypermedia environment the user may quickly become lost and has no idea of how to proceed. This map allows the user to look at the overview of the training materials and choose the desired segment.

As with any training material information about how users employed the materials can be very important. Unfortunately, in the past it has been very difficult to monitor usage of training materials since monitoring has required some combination of specially trained observers, videotaping of training sessions, specially constructed areas to allow observation via one-way mirrors or monitoring devices. This has made collection of information about the use of training materials a very expensive, sometimes biased, and sometimes intrusive undertaking. This prototype captures certain information automatically: the path that each user takes through the material, the amount of time spent on each frame, and any user responses to questions posed. This information alone is not enough, but it gives information that was not available before, and it can be supplemented by other observations and evaluations of the training materials. Further, this information is captured inexpensively, is objective, and is unobtrusive.

A further advantage of rapid prototyping is that the training material can be updated and expanded in an ongoing manner. As certain aspects of the material are developed they can be tested, revised and retested. While the early prototype is more useful for informing the developer the later prototypes can be useful training, while development and evaluation continue. The early prototype goes through many stages of development to become the late prototype, which is the version 1.0 of the deliverable product.

CONCLUSION

Hypercard provides educational and training developers with a new and powerful tool. It allows developers to quickly prepare prototype materials that can be tested, evaluated and revised, these developers are using the same rapid prototyping concepts currently being applied in software engineering and are at the same time gaining valuable, measureable information about the use of training materials.

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UTILIZATION OF LASER VIDEODISCS AND SENSOR PROBES IN AN ELEMENTARY SCHOOL SCIENCE TRAINING INSTITUTE

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ABSTRACT

The participants in Northwest Missouri State University's School Science Improvement Project were able to improve their ability to utilize computer technology in science education. The elementary teachers had an opportunity to experiment with microcomputer based laboratory equipment. They conducted science activities with several commercial kits which provided directions for experiments involving heat, light, sound, and motion.

The project also included an opportunity to become acquainted with laser videodisc technology. The teachers received instruction in the use of the hardware and the basic principles involved. They learned to use authoring software to create their own videodisc instructional packages. An Outreach Program during the fall of 1988 enabled the teachers to borrow the hardware necessary to conduct microcomputer based laboratory activities and to provide classroom instruction through the use of laser videodisc technology.

INTRODUCTION

Science education, particularly at the elementary school level, suffered from the "back to the basics" movement in the 1970's. Today, in the state of Missouri, science has been emphasized as one of the four basic content areas. A problem exists, however, with regard to the degree of preparation of current teachers to teach science in grades K-6. While there are a number of teachers who have taught science in an exemplary manner, many teachers have not received adequate preparation in science.

The goals of the School Science Improvement Project were to promote the teaching of science process skills, content, and specific attitudes. In addition, the project faculty sought to increase the use of technology in science education by involving the participants with computer software, computer interfaced sensor equipment, and interactive videodisc equipment. This paper describes the School Science Improvement Project activities related to these goals.

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METHODS

Microcomputer-based Laboratory Applications

The recent development of microcomputer-based laboratory (MBL) applications provides an opportunity to achieve these goals. MBL activities permit the computer to become an instrument which can measure, transform, and display information in a table or a graph, thus enhancing the use of the computer. Tinker (ref 1) suggested that microcomputer-based activities may offer students unprecedented opportunities for scientific investigation of a sophistication unknown just a few years ago.

Researchers have described a number of benefits from the use of MBL activities. Sensor probes can be used by students to 1) design experiments, 2) gather real data, and 3) analyze and interpret results. (ref 2, ref 3, ref 4, ref 5).

Course Outline

The teachers received instruction in the use of sensor probes through the use of a videotape, descriptions, and demonstrations of various MBL packages. They also had the opportunity to conduct a number of experiments using sensor probe kits.

Problems

Even though sensor probes are beneficial in the science classroom, there are several factors which can limit their use. One problem is the ease of their use. Students at the elementary level may not be able to successfully use them because the probes can be difficult to manipulate. Safety is also a primary concern when dealing with elementary students.

Reactions

When the teachers started using the probe kits, most of them showed some apprehension. However, as they became familiar with the apparati, their apprehensions turned into enthusiasm. The teachers enjoyed using the probes and being able to quickly gather and analyze data.

However, the teachers' abilities to use the probes varied widely. Some of the teachers immediately understood the directions and had little difficulty forging ahead on their own. Other teachers seemed to find the probes a little difficult to use and needed more explanation and reassurance.

Interactive Videodisc Technology

Another technological advance that has seen increased use in the science classroom is the interactive videodisc. This apparatus combines a videodisc player with a videodisc to present high quality images on a television monitor. In addition, this apparatus can be controlled with a microcomputer to provide instruction over several different topics.

Course Outline

The teachers received instruction in the use of videodiscs through description of the hardware, instruction in the use of authoring software, and the development and demonstration of a videodisc lesson.

Problems

Parts of the videodisc equipment can be vulnerable and damaged if not correctly handled. For example, the tray in which the videodisc platter rotates and the connector prongs from the videodisc to the computer can be damaged by inexperienced students.

Another problem is the high cost of videodisc equipment. Very few schools can presently afford to purchase these systems.

Reactions

The science teachers did suffer from high technology anxiety, even though they understood how all of the pieces of equipment worked. This anxiety did cause some hesitation at first in using the videodisc systems to prepare their lessons.

As teachers became more familiar with the videodisc equipment and began to master the authoring system, the lesson design teams became competitive. Each team tried to surpass the other teams in the creation of more sophisticated lessons.

OUTREACH PROGRAMS

During the fall of 1988, the School Science Improvement Project employed an Outreach Teacher to visit the participants' schools. The duties of this teacher included delivery of materials and equipment from the resource collection. Videodisc systems were delivered to school sites for two week periods. Computer software and sensor-probe equipment were mailed or delivered during scheduled visits.

Evaluation

Evaluation of the benefits obtained from the project were based on several sources. Early feedback was obtained by analyzing videotapes made of the microcomputer-based laboratory sessions and the laser videodisc sessions. A videotape analysis indicated that the participants were very successful in receiving retraining about science instruction using new technology.

CONCLUSION

The participants in Northwest Missouri State University's School Science Improvement Project were able to improve their ability to utilize computer technology in science education. The course included activities which used microcomputer based laboratory probes to conduct experiments with heat, light, sound, and motion. In addition, the teachers had an opportunity to utilize laser videodisc technology.

The success of this project indicates that elementary school teachers can acquire technological literacy for use in their science classroom. While the impact on students remains to be seen, the authors feel that computer technology can definitely be used by elementary teachers to extend and enhance educational science experiences.

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USING EXPERT SYSTEMS TECHNOLOGY TO DEVELOP SCIENCE TEACHING AND PROBLEM-SOLVING SKILLS IN ELEMENTARY PRESERVICE TEACHERS

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ABSTRACT

Described is an ongoing project focusing upon applications of artificial intelligence-based expert systems technology to enhance the skills of elementary education majors in classroom science instruction. In the project, a prototype microcomputer-based expert system (ESCT) provides consultive support to elementary preservice teachers enrolled in science methods courses by facilitating their mastery of concept teaching skills as instructional problem-solving tools. With the expert system serving as a training supplement to regular course lectures, the participants apply selected concept teaching skills from Engelmann and Carnine's (1982) direct instruction model: (a) to analyze concepts in elementary science textbooks (i.e., grades 1-6) and select appropriate concept teaching algorithms, (b) to construct teaching sequences for introducing and expanding student concept understanding, and (c) to gain an improved self-confidence toward their own ability to successfully teach science content. Additionally, participants are expected to demonstrate an improved capability for teaching science concepts in classroom settings during subsequent field experience assignments.

INTRODUCTION

Despite an optimistic view toward the long-term evolution of a comprehensive research-based science pedagogy, the practice of science teaching in elementary schools and the preparation of elementary teachers for science instruction must solve a number of immediate problems. Although research emphasizes the need for building the scientific knowledge of K-6 students through in-depth cumulative understanding of concepts and concept relationships, elementary teachers in recent years have reported an alarming trend toward using more passive textbook-dependent lecture activities and rote memorization. Other research has found that teachers in elementary schools commonly either avoid teaching science in favor of other subjects or present it in a half-hearted fashion as collections of isolated facts, a practice encouraged by the encyclopedic organization of many elementary school textbooks.

Because classroom teachers are recognized as the most crucial element in elementary science instruction, concerned science educators have begun to examine the preservice teacher preparation process critically. In doing so, they have concluded that the fragmented scientific and pedagogical information in undergraduate science and methods courses cannot provide teachers with the basic discipline-specific knowledge and skills they must have in order to perform such crucial instructional tasks as determining developmentally appropriate conceptual goals for children, introducing science concepts

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meaningfully, recognizing student flaws in intuitive thinking, and providing guidance toward a scientist's view of the discipline. Supporting these views, practicing teachers have reported a need for increased inservice training on background science information and on the use of improved non-text instructional print materials and activity-centered learning tasks.

Certainly, a successful long-term research agenda could be expected eventually to cause systematic changes in K-6 elementary science curricula and pedagogy at some future date. However, in the meantime, there is a need to address the more immediate need of providing teachers with the instructional problem solving skills they require in order to contribute toward the improvement of science instruction in elementary schools using the curriculum models and textbook materials available to them at the present time.

PROJECT DESIGN AND OBJECTIVES

The overall project goal is to enhance the science concept teaching skills of elementary preservice teachers through artificial intelligence based expert systems methodology. Because the teaching skills for concept introduction, expansion, application, and scheduling included in the system are applicable to a wide range of science instruction, they potentially represent an important teacher instructional problem solving capability. In providing a valid implementation context for the project, the participating preservice teachers are enrolled in regular elementary science methods and follow-up field-experience courses within which the problem solving concept teaching skills component is embedded.

Clearly, the focus of the project is upon instructional problem solving skills in a form that are ultimately usable by teachers in regular elementary classroom settings. With this goal in mind, the following specific project objectives are:

1. To validate the use of an expert system designed to provide consultive assistance to preservice teachers in science concept pedagogy,

2. To train preservice participants to analyze and classify concepts in elementary (i.e., grades 1-6) science textbooks, select the appropriate concept teaching algorithms, and construct initial teaching and expansion/application teaching sequences,

3. To engender in participants an improved self-confidence toward their own ability to successfully teach science content.

As part of the design process, the project will identify methodological approaches and criteria through which the expert system can be validated and assessment tasks through which the performance of the participants can be compared to controls.

TECHNICAL PROJECT RATIONALE AND SUPPORTING RESEARCH FOR IMPROVEMENT OF SCIENCE INSTRUCTION

The primary purpose of expert systems software is to provide individuals with consultive information in a form that simulates the role of a human expert assisting with a problem-solving task. As such, expert systems applications fall within a continuum of various decision support systems or intelligent performance aids that offer enabling software environments ranging from knowledge-based support on one hand to constructive knowledge-testing simulation environments on the other. As might be anticipated, expert systems have proven to be extremely beneficial in a wide range of settings whenever sound problem-solving knowledge (i.e., expertise) is encoded into computers for subsequent use in settings where specialized human experts are unavailable.

While the detailed mechanisms underlying various forms of artificial intelligence-based expert systems are highly technical, the idea itself is straightforward. First, expert information in the form of IF/THEN rules is encoded as a knowledge-base into an expert system software "shell". In practice, commercially available software "shells" are used for the development and delivery of an expert system application. Since the purpose of the rules is to represent the governing conditions (i.e., "IFs") for procedural actions (i.e., "THENs") followed by an expert problem-solver, the knowledge-base may be as simple or as complex as required to simulate human expert behavior in the problem domain. Second, depending upon the problem goal and conditions associated with a specific application, the expert system software "shell" sequentially queries an individual for detailed local information and follows heuristic guidelines to apply appropriate rules until the "best" solution is reached. Throughout this process, the software "shell" also allows the user to request rule-based explanations regarding the systems actions. Third, the rules in the knowledge-base are refined in stepwise fashion as the system is used in order to improve the consultive value of the system in subsequent applications.

Within the field of education, implications for a range of expert systems applications have only begun to be recognized, particularly with regard to their potential use as a preservice training-aid. However, research has clearly shown the value of using computer-based software as a direct training link between reading/lecture and field practice to support the development of teacher classroom skills. Without the availability of detailed guided practice to facilitate skills mastery and transfer, researchers argue that preservice teachers are faced with too broad a range of ambiguous skill applications, far too many simultaneous skill training demands, and too little detailed attention from supervising instructors. Although expert systems applications in educational practice are just beginning to appear, the potential of "small" knowledge-based systems in preservice education seems well on the road to being well established.

CONCEPT TEACHING RULES AS AN EXPERT SYSTEM KNOWLEDGE BASE

Within the rationale of this project, preservice teachers are considered to be faced with the problem of gaining skills for designing effective introductory and expansion teaching sequences for science concepts addressed in elementary science textbooks. In turn, such student core concept mastery also can be considered to be a highly facilitative prerequisite for textbook referenced "hands-on" science activities. Thus, the role of expert systems methodology in this project is to provide preservice teachers with a consultive software environment that, in conjunction with regular science methods lectures, facilitates mastery of the instructional problem solving skills required for effective concept teaching through a series of guided practice applications.

Given the role of the expert system software in the project, selected concept teaching procedures based upon the direct instruction model described by Engelmann & Carnine (1982) serve as the basis for the rules in its knowledge-base. Although relatively new, direct instruction design principles have a strong research base and are rapidly becoming recognized as a highly powerful skill-base for training preservice and inservice teachers to foster significant school improvement. Additionally, the direct instruction design model is also particularly appropriate to science teaching in general and the present project in particular. First, Engelmann & Carnine's (1982) approach is highly consistent with both recent perceptions of concept science teaching and the more general concept teaching literature as well. Second, the concept (and concept relationship) teaching principles are highly algorithmic once the forms of concept knowledge to be taught to students in the classroom are categorized by teachers and, thus, well suited to a rule-based expert system. And, third, the model itself reflects validated curriculum efforts over a twenty-five year period during which Engelmann, Carnine, and their colleagues developed a great deal of sophisticated science concept teaching materials, initially within teacher-delivered reading comprehension programs (for elementary and secondary students) and, more recently, within core-concept videodisk programs in earth science and chemistry (for secondary students).

LONG-TERM IMPLICATIONS FOR IMPROVING SCIENCE INSTRUCTION

The goal of this project would improve the preparation of elementary education majors to teach concepts in science textbooks effectively, thereby, making better use of existing instructional materials in schools. Through this process, preservice teachers enrolled in science methods courses would complete science concept teaching tasks presented through lectures and follow-up field experience in conjunction with an expert system providing guided practice in the form of consultive support. Additionally, the technology in the project could be used for inservice teacher training as well, particularly as the expert system is enhanced to encompass other aspects of the Direct Instruction model. Eventually, increased technical sophistication of teachers would be expected to affect the quality and design of science textbooks, teaching resources, and school science curricular structures.

INTEGRATING ACOUSTIC PHONETICS INTO THE LANGUAGE CLASSROOM THROUGH REAL-TIME SPECTROGRAPHIC ANALYSIS

Garrett G. Molholt

ABSTRACT

Communicating about speech patterns through the visual mode has many advantages over traditional methods. Students are able to focus on precise and immediate feedback, monitor their progress, and gain confidence that they know how to control features necessary for adequate communication. Instructors are free from the need to slow down the course in order to introduce complex terminology and charts describing the production of speech sounds, and they are free from the burden of trying to use either non-specific feedback, such as "very good" or overly specific feedback, such as "I would like to hear less closure and more turbulence in your medial voiced fricatives."

INTRODUCTION

Though there are good reasons to improve instruction in pronunciation for language students, the teaching of pronunciation has lost popularity among many language teachers. This is because the traditional articulatory analyses of sounds according to places and manners of articulation are clumsy when applied to classroom teaching, especially if near native fluency is a goal of the instruction. By shifting the focus of instruction to real-time acoustic analysis in the visual mode on a split screen, instructors are free from the complex and often unproductive terminology, and the students are free from the burden of translating instructors' general comments into specific plans for action. Instructors are able to communicate clearly and directly with students about the exact location, size, type and significance of errors, and students obtain precise and immediate feedback regarding their progress. This paper reports on techniques developed to help over 300 foreign born engineers improve their pronunciation of English so that they could be clearly understood. Students include both people who had been in the United States for over 20 years and had given up all hope of trying to improve their English, and people who had recently arrived to pursue their graduate education and needed help so they could survive in a highly competitive academic environment.

METHODS

After individual interviews to determine needs, students who were judged to significantly lack proficiency were assigned to a course in Spoken English. which met 3 times per week for one hour. They were also assigned to a small group (5 to 7 students) which met one hour per week for pronunciation practice. This section used spectrographic analysis. After a brief introduction to the Kay Elemetrics Speech Spectrographic Display (SSD 8800), students were

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urged to participate in drill and practice sessions, presentations of prepared speeches, and free conversations. As they became more aware of how their speech patterns compared to native patterns, more emphasis was given to conversation, and less emphasis was given to using the machine. This facilitated the transfer of techniques from drills to real language use.

RESULTS

Complaints from native students about the communication skills of their international professors and teaching assistants decreased. Several departments set up procedures mandating participation of all international teaching assistants in the program. Students often commented that they never really knew before what they problems were or that they could actually solve them.

GRAPHIC INTERFACES FOR COMPUTER SIMULATIONS: A VEHICLE FOR ENHANCING THE PRIMARY SCHOOL CURRICULUM

W.Hall*, J.Layman•

ABSTRACT

The design of the user-interface is crucial to the successful use of computer simulations in education. In the primary classroom, problems with readability, retention of information from one screen to another and recall of operating sequences, add further constraints to the interface design. This paper describes how a complex real-world problem can be presented as investigative learning material to primary school children through the use of an interactive graphic interface in the form of a graphical spreadsheet.

INTRODUCTION

The use of computer simulations in teaching and learning is well documented (ref 1). Realistic computer simulations are particularly useful where systems cannot be otherwise modelled in a classroom and where repeated practice of skills is required by the learner (ref 2). Generally this is because the system is large, slow changing, complex, inherently dangerous, partially complete, unavailable or unstable or some combination of these. Particularly powerful teaching mediums can be built where relevant systems can be realistically modelled while the unnecessary operational complexity is masked from the user (ref 3). Such computer simulations, if operated through a suitable interface, can help the learner focus on concepts, procedures and details through an investigative approach.

The importance of investigative work in childrens' learning has been established for some time (ref 4). Detailed research into four specific areas of pupils' understanding has been conducted by the Children's Learning in Science Project (CLISP). Learners conceptions of the complex areas of heat, energy, plant nutrition and the particulate nature of matter have all indicated that more time should be spent on investigative work and discussion of ideas (ref 5). Similar statements about the need for 'active engagement' appear in the National Curriculum Interim Report (ref 6). This emphasis is in part because whilst concepts and processes are clearly essential, there are other valuable operations which are necessary to 'do' the investigation (ref 7). These might typically include the identification of dependent and independent variables and a grasp of procedural understanding in the experimental design.

The motivational and learning power of combining the two procedures; computer simulation and investigative learning, has already been recognised. O'Shea and Self (ref 1) describe the motivational advantages of using a computer in simulation work and Hall and Layman (ref 8) report that computer simulations of complex real-world processes can be used together with an investigative learning style to enhance thinking and problem solving skills amongst young learners.

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Much of the research reported in the literature has been conducted with senior school pupils (14 years and above). This paper reports on an attempt at making a complex model available to primary school learners (8 - 12 years) by front-ending to the model a newly conceived graphical interface supported by appropriately targeted investigative materials.

THE CLASSROOM REQUIREMENT

Energy and power form an essential part of the primary school curriculum. In UK primary schools, electricity and the role of electrical energy in peoples lives is tackled thematically through topic work. A likely scenario is one where the teacher takes the theme of electricity or energy and plans the entire curriculum for several weeks from a topic web that at its heart has the topic of power, energy or electricity. Hence this topic becomes the vehicle for mathematics, language, science and all areas of the curriculum. The authors have attempted to provide a computer simulation (ref 9) that is central to this topic web approach, can trigger all these curriculum areas and also facilitate the powerful techniques of investigative learning. The resulting package can therefore fit the thematic or topic model and can also be used to provide practical work in traditional curriculum areas, such as mathematics, science, geography, where subjects like energy and power are also tackled.

THE NATURE OF THE SIMULATION

Mains bourne electricity cannot be effectively stored and so consumer demand must be matched by production at the power stations. This is done by using the cheapest stations in the network first and hence at periods of large demand more stations will be needed automatically requiring lower ordered stations to be brought into service. This will affect the unit cost of the power supplied. To safeguard against sudden unexpected demands for extra power the system has certain rules. Since a completely unused station in the network will require a startup time of 40 minutes to an hour before it can generate power, some stations must be held in reserve, spinning but not generating. Technologies such as pumped storage stations have also been developed that allow an almost instantaneous response to power output demands. Consumer demand however is not entirely erratic, and patterns are well established on a regional scale. Weekend breakfast peaks are slightly later, industrial demand is low on a Sunday, and summer and winter differences are well known. Even at a simple level this model of electricity supply has complex rules and flow lines. Both the flow line directions and the rules can then be modified by conditional statements that involve weather patterns, special events like royal weddings, and maintenance schedules and breakdowns. Clearly if the aim of giving children a compelling simulation with which they could experiment and learn was to be realised, a simple, uncluttered interface was required. This also needed to be presented in a manner that avoided readability problems and did not require frequent reference to a support manual before success could be achieved.

THE DESIGN OF THE INTERFACE

The design of the user interface is extremely important in ensuring that the teacher and learner find the use of the package an effective and engaging experience. Therefore, an early decision was reached that the interface should involve just one screen. Schoenmaker et al (ref 10) consider that access to an educational software package should provide ease of use and consistency; control and support; strong visualisation; extendibility;

and adaptability. They propose an interactive graphic environment using dialogues, pictures and animations similar to the classic WIMP interface. Veith (ref 11) reviews the term graphic interface and uses it to refer to icons, windows, graphically arranged menus of many kinds, highlighted options, diagrams and maps, and a range of other means for *visually prompting users of computers and computerised information systems*. Graphic interfaces are therefore associated with user input and are techniques for keeping users informed of actions that are possible and choices that can be made. Spreadsheets permit input, output and processing of data, and may have hierarchical and relational statements; dynamic revision of values in the investigational mode; and encourage the logging and transfer of data (ref 11).

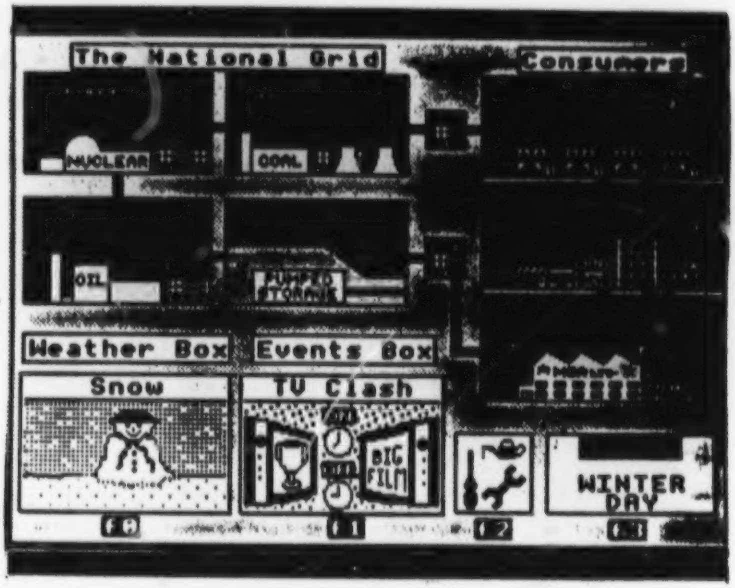

Fig. 1 User interface for Primary Power Package

The single page interface (see fig. 1) adopted for Primary Power Package (ref 9) delivers the properties of educational interactive graphic interfaces demanded by Schoenmaker et al and offers the functional characteristics of a spreadsheet defined by Veith. It is a variety of graphic interface not previously reported in the literature that is generically best described as a sub-type of a spreadsheet. Hence the authors term graphical spreadsheet.

The flow lines through the interface reveal a complex routing matrix. The hour of the day and the season are the primary independent user inputs. These determine output in the consumer boxes giving single bar graphs of power demanded by consumer type (domestic, retail and commercial, and industrial). These outputs themselves become inputs to the network of power stations. This section of the spreadsheeet has a number of relational, hierarchical and conditional rules that determine operational levels for each station. The principle rule however, is that output here must match the consumer demand except in situations that amount to power cuts. Further effects can be fed through these rules by imposing special events and weather changes that act through the demand side, and maintenance schedules (f2 in fig. 1) that operate through the supply side. The screen therefore dynamically models pictorial, graphical, digital and textual revisions to various boxes or active areas.

The model is simple to control and the instructions, if needed, are contained on a single illustration that can be kept near the machine. The educational support materials that encourage investigation of the system focus attention on various areas (often quite small) of the screen and include activities away from the machine, simple experimental design, logging of output values and open ended problems that offer a variety of solutions and approaches.

CONCLUSIONS

The computer package described in this paper has been successfully used in many UK primary schools to enable young children to understand the principles of operation of the electricity supply industry. The support material suggests various ways in which the program can be used as a basis for investigational work. Although initially a primary project, the power and ease of operation of this simulation has successfuly extended its application to senior school pupils and above. This widely-based success suggests that there may be potential for the development of authoring systems to permit the construction of generic interfaces for graphical spreadsheets.

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Selecting An Authoring System: A Review and Critique of the Options

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ABSTRACT

Selecting an authoring system or language involves matching the language or system to the Product, the Production Environment, and the Producer. Little attention has been paid to the issue of matching the authoring system to the cognitive styles of developers. Following Turkle's analysis of programming styles, two programming styles, Hard Mastery and Soft Mastery are described. Producers with different styles use different approaches to development (Top down - Structured versus Bottom up - Developmental) and therefore may be most productive with different authoring systems or languages.

The selection of an authoring system or language (ASL) is a complex process that calls for consideration of many different aspects of the courseware development process. Those aspects can be divided into three different categories: the Product, the Production Environment, and the Producer. These three categories will be more or less important in different projects, but they all should be considered when selecting an ASL for any project. Matching the ASL (or language) to the product and the production environment have been discussed in detail elsewhere as well as the desirable features of an ASL (Hazen, 1987; Leiblum, 1988). This article will concentrate on the third category, matching the ASL to the producer.

MATCHING THE ASL TO THE PRODUCT

The wide range of courseware content and format virtually guarantees that no one ASL will be suitable for all courseware development projects. That is one reason why some ASLs sacrifice a breadth to be maximally useful for particular *content* areas such as psychology or physics or particular *formats* such as simulations or hypertext. For example, ALIAS is a HyperCard-based tool for creating "cultural, social, and historical simulations" (Academic Information Resources, 1988). In the physical sciences Scanlon and Smith (1988) described the Alternate Reality Kit (ARK) for creating interactive simulations in physics.

For those interested in developing a wide range of courseware using the simulation format, Extend (Imagine That, 1988) might be suitable. It does not have a warehouse of parts for physics experiments as ARK does, but it has the flexibility to develop many different types of simulations.

For those interested in creating stackware or hypermedia Apple's HyperCard is an effective tool. Owl International's Guide 2, for IBM compatible computers and the Macintosh, is also an excellent medium for creating hypertext documents.

Content and format issues are thus very important when selecting an ASL. [Note: A third aspect of the product match - the type of information to be taught (e.g., declarative information, procedure, intellectual skill) is discussed by Gagne (1987) and Johassen (1988)].

MATCHING THE ASL TO THE PRODUCTION ENVIRONMENT

It goes without saying that the ASL must be matched to the computer equipment to be used. The personnel on the development team should also be considered. In settings where specialists such as programmers, graphics designers, and video production staff are available, the ASL selected should generally match the preferences of the programmers, and it should be able to import or control graphics, text, and video produced by other specialists with the software they prefer. Where one person (or a small group with similar talents) will be creating the courseware, the ASL should have as many built-in features (e.g. for creating graphics and sound, for controlling videodiscs) as possible. It should accept the output of programs that can be easily learned and used.

MATCHING THE ASL TO THE PRODUCER

Hazen (1987) pointed out that different types of software developers prefer different types of authoring tools. A content specialist might want a menu-driven ASL with many learning aids that can be learned quickly. A programmer might not consider any of those criteria important. The programmer might look for an flexible ASL or programming language subroutines or procedures for analyzing student responses and

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making sequence decisions. The programmer may want a system that fits his or her style of programming and works like a familiar standard programming language (Hazen, 1987). Extend's simulation scripting language, ModL, for example, is very similar to C. C programmers can begin using Extend with a minimum of effort and retraining.

The issues discussed thus far are important, but there is another aspect of the Producer match that has not generally been considered, however.

Hard and Soft Programming Mastery Styles

The focus of Turkle's (1984) book, *The Second Self*, was broader than the issue of programming styles and preferences, but her research has a great deal to say about the match between the ASL and the psychological and cognitive style of the developer. Turkle's description of the way two fourth grade students, Jeff and Kevin, approach programming exemplifies her concept of Hard and Soft Mastery styles. Jeff was a prototypical Hard Master. He began work on a program to simulate a space shuttle by developing a global plan and then breaking it down into small, managable units. He thus uses the familiar top down, structured approach. Jeff thus "conforms to our stereotype of a 'computer person' or an engineer, ... someone organized, who approaches the world of things with confidence and sure intent, with the determination to make it work."

Kevin, by contrast, is "dreamy and impressionistic. Where Jeff tends to try to impose his ideas on other children, Kevin's warmth, easygoing nature, and interest in others make him popular."

Kevin does not begin work on his space shuttle program with a master plan. Instead he experiments, he makes several false starts which are abandoned, and when he does develop something he likes, he finds many small details that he wants to change. He adds a window so the astronaut can look out; he adds planets and a moon to the background and insignias to the ship. Kevin gets the idea to create a red flame at the bottom of the rocket when he discusses his work with friends. Kevin's approach to programming is clearly Bottom Up-Developmental. He begins with a vague idea that evolves and is defined as he works at the computer.

Turkle points out that Kevin is " led by the efects he produces. Since he lets his plans change as new ideas turn up, his work has not been systematic." Kevin sometimes looses track of things and must take time to retrace his steps. He learns from errors, however, and is comfortable with the process. When discussing his space ship program, Kevin says "I'm me in there, driving the spaceship." Jeff, by contrast, thinks of himself as the sprite he is trying to program.

Turkle calls Jeff's approach to programming Hard Mastery. "Scientific and technical fields are usually seen as the natural home for people like Jeff." The arts and humanities are the natural home of people with Kevin's Soft Mastery approach.

Turkle's mastery styles are remarkably similar to Snow's concept of two academic cultures - science and the humanities. The table below emphasizes the differences between these two cultures:

HARD	**SOFT**
Top Down Preplanned	Bottom Up Emergent
Abstract	Concrete
Control	Compromise, Accomodate
Master the Medium	Work With the Medium
Objective	Subjective
Things are Right or Wrong	There is a Middle Ground
Sharp boundaries	Fuzzy boundaries
Objective	Subjective
Macho, Male	Feminine, Female
Complete Mastery	Adequate Mastery
Mathematician	Painter
Abstract, Formal	Concrete, Sensual
I-It (subject/object	I-Thou (subject/subject)
Distant	Close
High Priest	Citizen Participant

Turkle believes that educational expriences that force Soft Mastery students to approach topics such as mathematics from a Hard Mastery perspective are often unsuccessful. The problem is not with the subject matter, but with the mastery style imposed.

This same point can be made about ASLs and languages. Work in fields like computer science, mathematics, and the physical sciences often calls for hard mastery approaches, and many of the people in those fields, which are the traditional users of computer technology, have hard mastery styles and prefer Top Down Structured programming styles. By contrast, people in *new user* fields such as the humanities, the arts, education, and some of the social sciences are likely to have soft mastery styles and prefer Bottom Up Developmental programming styles. It would be unfortunate if many of these new users abandon their interest in instructional software development because hard mastery types insist they use languages and ASLs more suited to a hard mastery style than a soft mastery style.

Programming Styles, Personality, and Intellectual Cultures

The Top Down-Structured model is so ingrained in both the people and the procedures of the hard sciences that it is often taken for granted as the One True Way things should be done (Price, 1987). This intellectual imperialism is one aspect of the problem discussed by Snow (1966) For Snow there were two cultures - science and the humanities, and he was concerned because members of these two intellectual cultures not only do not communicate with each other, they often express considerable hostility toward the work and goals of the other culture. Klabbers (1987), in a paper that discusses a dichotomy in the field of simulations, uses the two culture analogy to explain why we have two different traditions in simulation research. These two traditions even use different terms, simulation and gaming. "Simulation is considered to belong to the realm of the so-called hard sciences, whereas gaming - especially the role-playing variety - has more affinity to the social sciences. Klabber urges us to develop more lines of communication and accomodation between the two groups (which suggests he has a soft mastery style).

Klabber's *gamers* and *simulationists* and Snow's two intellectual cultures occupy some of the same territory Turkle assigns to hard and soft mastery styles. Faculty in the soft disciplines have been much slower to take advantage of instructional technology, there is less instructional software development in those disciplines, and fewer faculty use computers in their classes (Willis, 1988; Danielson, 1987).

Weissman (1987) in his article, *The Two Cultures of Academic Computing* points out that "the kind of algorithmic formalism found in much computing documentation is ... considered alien and hostile to the spirit and culture of the academic comunities ... of these new users." Faculty from the soft disciplines generally have little interst in the "mathematical abstractness, the structured algorithms, and the rule-based logic of programming languages." If potential courseware developers from the soft disciplines (called *new users* by Weissman) are become active courseware developers, they must be given a chance to work with the computer in ways that match their personalities and their programming styles. That will not happen if the hard mastery staff and faculty assigned to help new users believe the approach they prefer is the One True Approach. This issue involves both the selection of an ASL and the way the ASL is used.

Matching Styles to ASLs and Languages

Most ASLs that can be used comfortably by a Bottom Up-Developmental programmer can also be used in a Top Down-Structured style. The Alternate Reality Kit, for example, fits the Bottom-Up Developmental approach. It can also be used by developers with a Top Down-Structured style. Hard mastery software developers could introduce new users with soft mastery styles to ARK without forcing them to adapt their programming styles. Unless new users are given the opportunity to follow their own programming styles, progress will be retarded in the soft disciplines.

Not all ASLs do not have style flexibility. Extend, which has already been discussed, is more suited to the Top-Down Structured approach. Despite that, it would be a much better choice for a soft mastery software developer than modeling languages such as Dynamo (Roberts, et al., 1983) or TUTSIM which call for a much more structured, top down approach.

Programming Styles and Two New ASLs

Those who assist new users who want to develop their own courseware should help them select an ASL and programming style that fit their natural way of thinking. The final section of this paper discusses two relatively new ASLs that can be used in either a Top Down Structured style or a Bottom Up Developmental style. Course of Action and Course Builder are both for the Macintosh computer. Both are excellent, well designed ASLs, and both can be used to develop many different types of instructional software.

Course Builder. Many of Course Builder's commands and procedures are patterned after those of MacDraw and MacPaint. The package includes extensive documentation, an audio-tape and printed tutorial, and a large number of sample programs. Instructional software created with Course Builder can incorporate music and synthesized speech (relatively low quality) created with MacinTalk (which is supplied with Course Builder) or digitized speech (high quality but imported from MacRecorder which is not supplied), pixel and animated graphics created with Course Builder or standard Macintosh software, and video from a videodisc or videotape system. Stacks created by HyperCard can also be accessed and used by the program.

Course Builder's stated operating metaphor is Knowledge Navigation, but in reality the metaphor is that of a road map. It is based on blocks of information called States. States have Entrances and Exits where Routes come into and leave a State. The Routes students can take through the States are defined by a course Map you create which defines how Routes interconnect States and Group (a collection of States).

Course Builder can be used in a Top Down Structured style, but it is equally amenable to a Bottom Up Developmental approach. It is relatively easy to modify States, change Routes, add new States or Groups, and move States or Groups from one location in the course to another. The major complaint we have against Course Builder is the road map metaphor. This is not a natural metaphor for courseware development and it sometimes gets in the way. It adds another layer to the cognitive process of courseware development without offering much benefit. Course Builder's metaphor mismatch is not nearly so serious as that of ScriptWriter, an ASL for IBM PCs (Horowitz, 1987). In ScriptWriter you are the director and author of a play (the course you are developing). Elements of the course are players and you can write scripts for each player.

As director you place players on the stage (the sequence of the coureware). The play metaphor forces you to translate your courseware ideas into the terminology of play production and then perform another translation to use the ScriptWriter's commands. Strip away the metaphor and ScriptWriter works much like a standard programming language such as C. It is most suited to a Top Down Structured style.

Course of Action. We have used this program to develop a teacher education simulation called IRIS (Informal Reading Inventory Simulation) to train pre-service teachers to administer an informal reading inventory. Course Builder can be used in a Bottom Up Developmental style; Course of Action virtually insists on being used that way. Course of Action's metaphor is that of a computer lesson. You build a course by selecting course elements and placing them on the screen. Elements are represented by icons on the left side of the screen. When you want to display something on the screen, you select an icon that looks like a computer screen. When you want to erase a screen you select an icon that looks like an eraser. To ask a question you select an icon with a large question mark in the middle. Course of Action's metaphor aids rather than hinders courseware development.

Course of Action also comes with extensive, well written documentation, a printed tutorial, and several program examples. The documentation is virtually jargon free, and it encourages use of a Bottom Up Developmental style. Course of Action, like Course Builder, also makes it easy to make a change in the course, run it to see how it will look to the student, make adjustments, and run it again. This modify-evaluate-modify approach is the heart of a Bottom Up Develpmental style.

The price of the standard Course of Action is a reasonable $495 to educational institutions. The standard version has powerful, flexible animation features, but it does not include the module for advanced animation. The standard version also does not include digitized sound software and equipment, software to control a Pioneer laser disc, or the software needed to convert courseware to run on an IBM PC. You can purchase each option for between $195 and $295, or you can purchase Best Course of Action for $1750 (academic price) which includes all the options.

Course of Action can be used to create many different types of courseware, but it is not the best tool for some. It is possible, for example, to create non-linear courswware that is similar to HyperCard's stackware, but the task would be easier with Course Builder.

The most serious criticism of Course of Action involves the way it packages courseware for student use. You must use special disks supplied by the developer, Authorware. Ten student disks cost $45 and there are quantity discounts, but what we have is a licensing fee. These have rarely worked well, and this one could be a major headache for colleges and universities where many students might use a popular program each year.

In spite of the criticisms, Course of Action is a powerful, easy-to-learn, easy-to-use ASL. We use it ourselves because of those features and because it has one unique feature. Course of Action runs only on a Macintosh SE or II, but the software developed can be packaged to run on any Macintosh, an IBM PC compatible computer, or an Apple IIGS. No other ASL has this capability.

The criticisms of both Course Builder and Course of Action are relatively minor when their flexibility and features are considered. Either can be used by developers with Top Down Structured or Bottom Up Developmental styles. The range of features, such as animation and speech synthesis, and the ability to produce many different types of software, should be of interest to novices as well as experienced developers currently using less powerful ASLs or standard programming languages. Either of these ASLs could save time and enhance the quality of the courseware produced.

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DESIGN CHANGES: TETRAMORPHIC COMMUNICATION FOR DESIGNERS

James Powell*, Paul Newland* and Chris Creed*

ABSTRACT

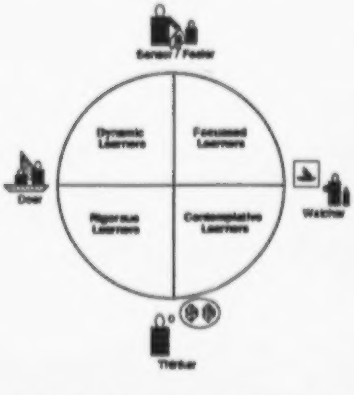
This paper portrays the role played by risk perception in the world views of designers. Indeed, are designers as a group biased towards perceiving particular types of risk, and does this engender consistent strategies for rejection of information? Our stance is not to criticise such rejection, we intend to defend its existence as a positive and realistic survival strategy for designers who are continually faced with the prospect of information overload. Brought forth from empirical studies of practising architects and a back drop of anthropological understanding, four fundamental and bounded strategies are indicated. Descriptions of these strategies, and the scenarios they suggest for creating acceptable information sets, are pervaded through an umbrella model. The model describes a four-fold or tetramorphic approach to the presentation of concepts to designers. At present this tetramorphic information transfer lies within a concrete application namely an interactive, computer managed, videodisc system. The potential of this medium to create tailored contexts for communication of ideas to designers is described and its role within the designer environment expounded.

INTRODUCTION - THEORY

The title of our paper hopes to convey the notion that if communication is to be effective it has to take a variety of forms. We believe that with this variety in the means of communication comes the opportunity for enhanced design awareness in individuals. This design awareness we define as the ability to hold a conversation where the contexts set-up by the participants allow messages to be passed between them which convey both experience and understanding in a form that each can interpret - a true reciprocity of perspectives. Our aim is to enhance the networks of human interactions - allowing these networks to grow and diversify. Enabling this variety, allowing for the difference in individuals, maintains requisite variety in the solving of problems. In this scenario all individuals are designers enabling each other to communicate messages - the creativity of each is mustered to support a conversation in the Paskian (1987) sense. Information purveyors become designers - we move from instructional interaction *there is something you should know*, to transactional interaction *there is a mis-match we should attempt to understand together*. This is true gift exchange where each acknowledges the other has as much to give as is received.

Our research concerns the theoretical human issues that relate to information transfer, especially those ideas relating to learning and communication styles. There is a bewildering array of cognitive strategies and styles identified in psychological literature concerning how individuals communicate with others. This has, so far, led to difficulties for those who wish to apply the results of research to the design of human-computer interfaces. Clearly at the most personal and psychological level all individuals learn and communicate in their own particular and rather idiosyncratic ways. Therefore, ideally each message that is given in a conversation or communication should come with a tailored context which allows individuals to explore with confidence and find the solution for themselves. However, taking these two statements onboard leads to a major concern, namely which contexts and how many - must there be a new one for each individual or pairs of communicating individuals?!! Arabic thinking on this topic would appear to give insight to a procedure which, while recognising this situation, still maintains cost effective communication.

For centuries the Arabs have had two words for teaching and we believe these lead to two options when considering means of conveying knowledge: the first of these words daras, literally means *to teach*, the second, *t'allum* means *to make to learn*. Our approach has been to tackle the problem at the *t'allum level*, by using interactive media to develop ICE (Interactive Communication Environments) along with a strategy which enables individuals to make themselves to learn. So our emphasis is away from trying to understand how individuals learn, and instead towards becoming the producers of improved information transfer systems. Systems which are trying to learn for themselves how to communicate with more aplomb.



EMPIRICAL STUDY

ICEs we see as having a cultural rather than psychological emphasis. This is supported by the studies of Thompson (1982) and Newland, Powell and Creed (1987) of designers' approaches to thinking and designing, which suggest they employ a particular set of culturally developed strategies when communicating and designing. There appear to be four 'strategy sets' which are viable and the particular 'strategy set' taken onboard by each designer is closely related to the way each learns about their world. The ideal for learning has been portrayed by Kolb (1976) as a cycle (see fig. 1, which is also represented in the top left-hand quadrant of fig. 2 - for discussion see later section). Kolb suggests a learner senses the world, stands back to reflect on this feeling, thinks to create an abstract model and tests this in doing - it is the re-sensing that takes place in this action that initiates a new learning cycle.

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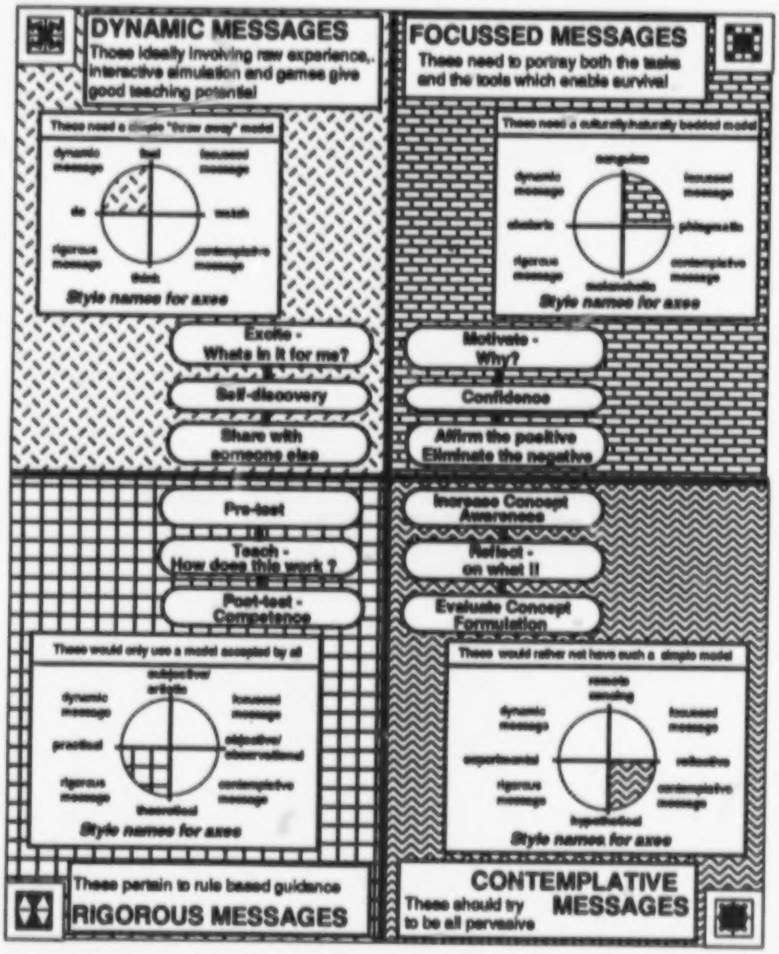
In the context of architectural design, however, this ideal cycle is very much curtailed, as Newland, Powell and Creed (1987) have shown, good decision makers tend to operate on shorter cycles. They align themselves with a 'strategy set' which allows them to make faster decisions. Some operate mainly within one arc or quadrant of the circle. For instance entrepreneurial types move on an arc between sensing and doing; whereas design engineers and technologists, such as lighting experts and acousticians, tend to watch the world and then think about it. 'Watching' here implies systematic observation. 'Sensing' is more intuitive and feeling based. It is important to stress that these observations are of architectural designers' preferred action styles. Someone who is mainly a thinker-doer is perfectly capable of sensing or watching. However, in practice, within the pressures of conventional management time, all decision makers will normally use (be willing to privately acknowledge) only that information presented to them in a style and manner conforming to their preferred way of acting in the world. Our research indicates that there are four useful ways of configuring information so it can communicate well to different individuals. For clarity we have named these configurations, dynamic messages, focussed messages, rigorous messages and contemplative messages. These in turn suggest four culturally based learner types for design – dynamics, the focussed, the rigorous and the contemplatives. These have been discussed in detail elsewhere, (Newland et al). However, we would briefly like to indicate how designers' cultural bias might affect the way they accept or reject information.

A FOURFOLD APPROACH TO INFORMING MESSAGES

In the remainder of the paper we will concentrate on giving an understanding of how information systems for design might begin to reflect the need for different messages.The domain of study we are exploring is that of problems. The particular solution we seek is an ability to attach contexts to messages which allow these messages to become effective enablers for each recipient, so each designer can solve the problem they have encountered, by themselves. Figure 2 attempts to summarise how even the above simple message should be re-constructed in order to make itself available to our four designer learner types, who bring with them, to any conversation or communication, a pre-existing understanding of the world and concomitant contexts for effective learning.


DYNAMIC MESSAGES
Those ideally involving raw experience,, interactive simulation and games give good teaching potential
These need a simple "throw away" model
dynamic message
feel
focussed message
do
watch
rigorous message
think
contemplative message
Style names for axes
Excite - Whats in it for me?
Self-discovery
Share with someone else
FOCUSSED MESSAGES
These need to portray both the tasks and the tools which enable survival
These need a culturally/naturally bedded model
sanguine
dynamic message
focussed message
choleric
phlegmatic
rigorous message
contemplative message
melancholic
Style names for axes
Motivate - Why?
Confidence
Affirm the positive Eliminate the negative
Pre-test
Teach - How does this work ?
Post-test - Competence
These would only use a model accepted by all
subjective/ artistic
dynamic message
focussed message
practical
objective/ observational
rigorous message
contemplative message
theoretical
Style names for axes
These pertain to rule based guidance
RIGOROUS MESSAGES
Increase Concept Awareness
Reflect - on what !!
Evaluate Concept Formulation
These would rather not have such a simple model
remote sensing
dynamic message
focussed message
experimental
reflective
rigorous message
contemplative message
hypothetical
Style names for axes
CONTEMPLATIVE MESSAGES
These should try to be all pervasive

By way of example let us employ the information latent in this diagram to solve the problems of individuals whose strategies we are not directly aware, but to whom we need to communicate. Our approach is to configure four messages – one from each quadrant – to ensure an appropriate message is available for our four learner types. Our individual is called Walter Wing and his problem – he can't swim!

The Dynamic Message (top left quadrant):–

Emphasis is on self-discovery – dynamics are encouraged to leap in and find out through raw experience by seeing the enjoyment of others. This exploration firstly needs to be private so that no loss of face is incurred. An action sequence on video of others positively engaged in swimming, would enthuse. A few confidence boosts like conveying the feeling that anyone can float, together with imparting the notion that the resulting instantaneous sensory pleasure can be fantastic, followed by a realistic challenge *to jump into the mid-depths of a warm, private pool* **should** do the trick (if presented well). Being highly entrepreneurial the sink or swim, all or nothing strategy will insight action and problem solving. Quite simply you need to excite the dynamics about the task inhand, get them to own the task and discover for themselves how to do it. Finally get them to teach the task (or concept) to someone else. For in doing this dynamics really do learn themselves. In our example, the need to teach their own children or loved ones how to swim, so that they would not be at risk, would be a good incentive.

The Focussed Message (top right quadrant):-

A down-to-earth approach is called for the focussed, providing initially a clear cut reason for undertaking such a task. Their *small is beautiful* philosophy would lend them to be persuaded by notions that it is beneficial to their fellow man if being able to swim is one of their accomplishments. With this motivation a step-by-step approach of instructions and diagrams and then finally a respected other person guiding their actions within a shallow pool, giving them continuous and incremental feedback, would enable and give confidence to learn and become efficient at this task.

The Rigorous Message (bottom left quadrant):-

For the Rigorous the confidence to undergo any experience is gained by it being perceived as a normal action with a formalised model. In our example, for instance, how the act of swimming should take place. Thus, the rigorous should be given a logical set of procedures which enable them to attain this ability. They also want a suitable examination to understand whether they have passed or failed, and especially to know how their action did or did not accord with the proper way. The algorithm of *pre-test – teach – post-test* provides a suitable theoretical, structured and standardised base to this activity. Perceiving action as an objective standard gives the impetus for the rigorous to take part.

The Contemplative Message (bottom right quadrant):-

For this person the decision *to swim or not to swim* is the major stumbling block. In order to ensure their reflective attitude is overcome, assurance must be imbued with a montage of information. The contemplative must slowly become aware of the concept they are confronting from a comprehensive data set. They would want to read about the theory and practice of swimming before attempting it. They must be supported in as wide a range of ways as possible, so that they can reassure themselves on all fronts. Finally, they should be provided with a context to experiment. A context where they can firstly watch others do it and work out their way. Then, if its also right for them they will have a go and be surprised how easy they find it. For when they try, these are usually most competent individuals. When successful communication occurs here the notion is pervaded as a *thoroughly natural ability* which is consistent with the overall scheme of human physical capabilities, with the recommendation that the experience is confronted gently in a tepid, calm river.

One of the above problem solving contexts and its related enabling message we feel should allow Walter to find within himself the ability to negate the need for his Wing(s).

A CASE STUDY

In order to give you a flavour of the way in which we have exploited this understanding in design we would now like to turn to a case study. It concerns the design of an information system to convey to dynamic learners why they should take fire escape design into their natural design process. Fire safety messages are relatively simple to understand, but are often not attended to. We all tend to throw unwanted leaflets, unread, into the wastebin; fire drills often seem unconnected to the real thing and a tiresome interruption to what we are wanting to do and few of us bother to read fire notices when we visit new buildings. Furthermore, while architects undoubtedly provide buildings that meet minimal fire codes, few are sufficiently motivated to try and understand people's rational behaviour when escaping, in order to design appropriately for building escape. With this in mind the design information specialists at Blackrod Interactive Services (BIS) have joined together with a group of building safety researchers in the School of Architecture at Portsmouth Polytechnic in order to try a new approach: an interactive videodisc (IV) simulation which attempts to give the designer a feeling of what it is like to be in a building that is on fire. In this interactive video simulation we initiate a context in which individuals are drawn into becoming a visitor to a building that catches fire. Individuals, acting as this visitor, interact with the system using a mouse controller. This facility enables them to activate one of a range of action options shown as a photographic menu on a television screen. When they activate any option they see 'point of view' video sequences which fully involve them in the experience of escaping from a building which is being consumed by smoke and fire. The complete range of options open to them in the simulation parallels the options available in a real fire situation. Thus they can experience and "feel" what it is like when faced with a fire escape problem and make "real" decisions without being at risk.

The BIS/DIRT team believe interactive video disc can help building designers understand the problem of using (and designing) buildings so that all can safely exit them when they are on fire. The team will demonstrate its present interactive video simulation at the conference or there is a demonstration tape available from the authors for interested parties. Clearly we cannot give you a true feeling of what that simulation is like in a written paper. However, for completeness let us briefly describe the typical use of such a simulation to give you a feel of how you might use it.

This simulation starts as you watch a man arriving at a hall of residence, a place he doesn't know. He goes to his room and you the viewer choose what he does next; explore, unpack, look out of the window and eventually go to sleep. Then, in the early morning, you are awakened by a crash. You make all the choices now and see what you choose and the effects of your actions. You can dress, look out of the window, go into the corridor (turning left or right). You can pack, telephone or even jump out of the window! The longer you take the thicker the smoke becomes in our simulation.
The large majority of our subjects move sooner or later towards the direction from which they entered the building. If they have delayed too long before they do this they are in serious danger for this route leads to the seat of the fire. There will not be time to return before the smoke conditions become overwhelming....ahhh!

The fire simulation created by the interactive disc has been experienced by over 130,000 individuals both in Britain and more recently overseas (where such is the interest that we are now making versions in Swedish and the Russian). Validation of the decision structures emerging from the simulation have been shown to replicate those who have stated their actions immediately following their escape from real fires. The evidence strongly suggests such a simulation is a valuable training tool to convey the nature of experiencing a fire and how to cope in this novel and high risk situation.

Our explorations of interactive video simulation shows it to be a powerful research and training tool in the context of peoples escape from burning buildings. Users enjoy personal involvement in the realism of the simulation and appear to acquire long lasting knowledge on appropriate actions and appropriate designs to enable appropriate exiting behaviour. Such personal experience can motivate dynamic designers to design exits to the spirit of the codes of practice rather than merely satisfying the letter of the law.

CONCLUSION

We feel any information transfer system – indeed anything that claims an intelligence status – should eventually be capable of conversing with individuals in a meaningful manner. A manner giving individuals the confidence to find solutions within themselves. The negative side to this approach is demonstrated by the computer HAL's reply in "2001; A Space Odyssey" – *I'm sorry Dave, but I'm afraid I can't do that* – perhaps the unhelpful facet of many typical information systems. However, even in this situation the message does enable Dave. He realises the solution to regain access to the Spacecraft, in the context he finds himself, must lie within his own capabilities. In the end he opens the door by his own actions. We feel it should be a fundamental goal of all information systems to communicate messages that enable the individual(s) interacting with them to find their own solutions, to their own problems, in their own way. This views information systems as supporting, since they do not remove the responsibilities of decision making from the decision maker. Information systems should not control the user.

If the intention is truly to enable any individual designer to learn, then control cannot be placed upon that individual. A message should come instead with a context which allows individuals to explore with confidence and find the solution for themselves, for the dynamic designer we feel the fire simulation is such an enabling experience. Our tetramorphic view helps us to acknowledge an individual designer's preference and in realising it usually relates to one of four cultural strategies, the tetramorphic view gives the opportunity to frame a message as if it pertains from the chosen context an individual enjoys. The confidence and ability to comprehend and act effectively with the content of this message is then greatly enhanced for the individual. Any information system should aim itself to design an environment in which such messages can be unfolded.

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Design criteria to optimise user acceptance of text/image database systems for Education.

M.Slade,W.Smith, and P. Woolliams,
North East London Polytechnic, United Kingdom.

DESIGN GOALS

Structured databases provide for a range of retrieval specifications from users. Our interest stems from seeking to provide such a resource for a extensive variety of teaching resource media. Thus it is required that material can be accessed, searched and selectively retrieved for display on a computer screen or printed.

This achieves two aims:

i) the efficient and cost-effective dissemination of existing teaching materials and

ii) an efficient system for the learner who can search and selectively retrieve.

The material can now be in any form including diagrams or images as well as text. We have observed an increasing expectation from both teachers and learners for computer systems to serve this need. The source of such material would either be in computer readable form (e.g. teaching notes that had been prepared using a word-processor) or existing material would be scanned using an OCR (Optical Character Reader) to convert to computer readable forms such as ASCII text, digital images and line vector drawings.

Satisfaction of these expectations involves two dimensions: a computer system that provides the technical facilities and organisational logistics to support the teaching methodology.

TECHNICAL FACILITIES

Specialist, non-standard, high cost technology has recently become available to service requirements for text/image databases. However, the potential educational user community is demanding technology which is both cost and technically efficient and has connectivity and portability to systems well established in both education and industry.

This paper draws upon our previous work in producing text/image database systems with acceptable performance for applications in education. We have attempted to derive design parameters from an analysis of both teacher/learner needs and current technical developments within the microcomputer arena.

The ubiquitous MSDOS/IBM-PC de facto standard was designed as a general purpose personal computer and not to optimise the particular applications associated with full text or picture databases. More recent models with higher resolution screens compete with the MAC environment. The modern microcomputer (especially if configured with optical storage) can be considered not to have storage capacity as a constraint.

Similarly, processor resource exceeds that available to most users of time-sharing systems.

Our design is based upon the premise that **retrieval** should be simple to use and highly efficient (i.e. fast even from very large 200 megabyte applications). Such performance should also be achievable with optical storage having regard to the differing nature of CLV recording and consequential differences in seek behaviour. Because of its increasing penetration throughout the education world, it is appropriate to develop and derive design criteria for generic text and picture databases on such systems. We have developed techniques which can include optical disk technologies to overcome some of the earlier limitations of the basic microcomputer and provide a cost-efficient delivery medium to satisfy evolving user demands.

Most word processors include some form of word searching which at first glance might appear to satisfy the text retrieval demand. This is normally achieved by scanning quickly through the word processing document testing each sequence of characters for a match with the query. Such scanning methods can produce satisfactory results in single documents that typically do not exceed 25 pages. The performance drops drastically for larger collections of longer documents and frequently do not allow for word conjunctions.

Our system provides not only for content analysis and retrieval from free-form text but similar analysis on data exported from structured operational databases. It is a development of a commercially available free text retrieval system CONCORD (Slade and Smith 1986).

In contrast, the field structure of a traditional database can be restrictive and not permit queries of a form that were neither conceived nor provided contemporaneously with the systems design. We have observed both pupil and teacher demand for interrogating and searching on comment fields which have not been implemented as record keys. This facility is inherent in our design. The performance on a system such as the one described, is maintained even in very large bodies of text. Thus searches of a complete curriculum are fast and efficient. Typically a search can be completed and the relevant paragraphs or section displayed from a WORM on an IBM PS/2 within a second.

We have sacrificed some of the speed of generating indexes when installing the system to ensure that efficient retrieval performance can be realised. (indexing is typically 5 megabytes of source text per hour on an IBM PS/2). Similarly, the explosion in total storage required is prejudiced to achieve the performance aims. The degree of explosion depends on the nature of the source documents: thus 1 megabyte of closely spaced full lines of text may explode by 1.5 megabytes. This explosion is less important in a system configured with optical storage,although our usual practice is to build the database on magnetic media and archive it to WORM. In practice, the indexing task has only to be performed once when the system is set up and does not detract from the final perception of performance by the user. It is to be noted that additional text can be appended without re-organisation of the existing indexes unlike traditional database methods. For this reason, our techniques consume storage space incrementally rather than exponentially.

As noted above, there is significant demand from teachers and learners for the retrieval of 'pictures' associated with text. Some 'picture' systems are already available e.g. Interactive video systems particularly in the area of computer based training. However, these systems, including LASERVISION and CD-I (Compact Disk Interactive), are essentially based on creating the video display by analog means. A sequence of video frames of low quality appears to be acceptable to the viewer because of the characteristics of the human eye which integrates variances from one picture to the next. Such systems do not support the direct printing of selected still frames of high quality.

TEACHING METHODOLOGIES

The resource is particularly suited to self-paced directed learning activities which is consistent with our experience of mounting revelatory workshops and other modes of learning.

Co-workers report that applications for text and graphics databases are pervasive across all aspects of the curriculum. The advantages of installing such facilities are many. We observe the "toy room" effect in which concentration spans are lengthened in the initial stages as well as the direct educational benefits related to the provision of selectable secondary source materials.

However, to exploit these opportunities, a considerable editorial investment is required in addition to the more obvious capital expenditure. Members of our research team are responsible for the delivery of a national (UK) legal education database which is intended to be supplementary to LEXIS in providing secondary material rather than the original statutes and precedents. In addition this database has the capacity to include images of original titles, deeds, treaties, covenants etc. We estimate a provision of one man-month per megabyte of final data is required.

Students from non-computing disciplines when monitored exhibit high levels of assimilation and achievement. Initially, there is a tendency for students to generate hard copy of everything they retrieve or produce. Very quickly, this behaviour is replaced by a contentment with electronic media and they only record/retain the access pattern rather than the material per se.

Our overall aim is to bring the power of the computer to the pupil/student as a readily used resource to enable the identification, selection and extraction of particular learning materials relevant to his/her needs. In conventional computer assisted learning, the teacher is providing a resource that controls what is learnt and how. In contrast, we are providing a resource where the learning ends are determined and managed by the student/pupil.

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EXPLORATORY MULTI-MEDIA ENVIRONMENTS

W. P. Dickson, M. Rosenberg*

ABSTRACT

The presentation will describe a research and development project that is attempting to bring insights from the design of exploratory environments in museums, such as the San Francisco Exploratorium, into the classroom. A conceptualization of features of exploratory environments that are observed in interactive museums will be presented to guide attempts at translating these environments into forms compatible with classroom constraints. The computer-based "exploratorium" differs from other applications of computer technology in being deliberately designed to invite exploration, evoke curiosity, and stimulate further exploration. The exploratory environment seeks to give children the feeling of freedom to run, roam, pause, poke, and play with images, ideas, and "objects" at their own pace and as they wish. The goal is to create an enclave in the corner of the classroom that allows children's imaginations to go exploring without leaving the classroom.

INTRODUCTION

Children spend a great portion of their waking hours in school classrooms. Occasionally schools arrange field trips to visit other places that differ fundamentally from classrooms. Among the popular places to visit are science museums, broadly defined. In recent years museums have become increasingly interactive and "hands on," with an increased emphasis on education for the public.

The enthusiasm and excitement shown by children in these settings is in marked contrast to the atmosphere in many classrooms, where children are frequently subdued, stationary, passive, and receptive.

The purpose of this presentation is to contrast and compare a variety of educational settings in museums and classrooms in order to create a conceptual model for the elements of environmental design in interactive museum settings that are appropriate or adaptable within the constraints of classroom settings. From this conceptual model, then, prototype activities derived from interactive activities in science museums are being developed on a computer for use in the classroom. Among these types of activity are the field trip, explorations of oneself, explorations of the physical world.

The computer-based "exploratorium" consists of a Macintosh computer equiped with a videodisk player, color screen, and printer, along with speech synthesis and a video camera. A videodisk of images from the Smithsonian Institution and a video camera are being used to capture images for use in this exploratory environment.

The "field trip" is used as a metaphor for visiting a museum, collecting "specimens," bringing them back, naming them, and writing a story, poem, or report about them. Another class of activities popular with children in museums has to do with allowing children to capture or manipulate some aspect of themselves as in the shadow room where children can freeze their shadow on a luminescent wall. The computer exploratorium is equipped with a

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video camera and digitizer that will enable children to capture images of themselves or other people or objects in the classroom. They are able to zoom in on their eyes, collect images of parts of themselves, "edit" images of themselves, merge pictures of themselves or their classmates with poems.

The presentation will include slides taken a museums around the country and examples of children using the computer-based exploratorium in prototype activities.

The presentation concludes with the question, "Why can't the classroom be more like a field trip to the Smithsonian?"

INNOVATION AND TOMORROW'S ECONOMY: THE WISDOM OF STRATEGIC INVESTMENTS IN A REGIONAL SCIENCE AND TECHNOLOGY RESEARCH BASE[1]

D. A. Hicks[2]

ABSTRACT

Technological innovation does not have a life of its own but rather is always deeply rooted in an economic setting and generally cannot be understood apart from that setting. While technical innovation inevitably shapes its host economy -- firm by firm -- it does so largely to the degree that the host economy is capable of leveraging the regional resources that shape, time, and channel it. This study offers a variety of specialized indicators of the science, technology, research and educational infrastructures by means of which metro-scale regional economies stage -- or fail to do so -- periods of growth and adjustment.

CRITICAL REGIONAL FOUNDATIONS OF TECHNICAL INNOVATION

The conventional wisdom suggests that a new global economy now exists which can be understood as nations in competition with one another. This study -- which seeks to marshall a diversity of evidence and use it synthetically -- begins with a different premise. **A nation's technology capacities are generally abstractions at best. Ultimately, the building blocks of national economies are the coherent and linked industrial bases found at the level of metropolitan-scale regions.** It is at this economic scale that the critical resources -- industry base, graduate research and undergraduate teaching universities, resident skill pools, financial capital, quality-of-life amenities, business services, and communication and transportation links to other regions -- all come together.

REGIONAL INFRASTRUCTURES FOR ECONOMIC GROWTH AND ADJUSTMENT

We are now witnessing the rise of a new breed of models of economic growth and development which assigns a pivotal role to concentrations of research activities and the infrastructures necessary to sustain them. They remind us that it is the science and technology infrastructures in-place within regions that facilitate the adjustment of their economies to external shocks, such as rapid fluctuations in energy prices, exchange rates, or patterns of international trade. The gaps among regions in their abilities to derive economic benefit from advanced technology can be traced not only to their differing capacities to create it, but also to their differing capacities to manage its adoption and implementation.

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[1] This paper is a brief overview of a larger study which illustrates how the nation's major metro-scale regional economies can be usefully benchmarked on a variety of specialized science, technology, and education indicators. Copies of the larger study may be obtained by written request from the author.

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INNOVATION'S INDIRECT INFLUENCE: NEW BUSINESS FORMATION

The large business sector -- symbolized by the Fortune 500 -- tends to dominate our understandings of the ways in which our nation's economy expands and adjusts. Yet, it does so in part through its relationship with the nation's massive small business base. Unfortunately, the incessant "churning" that characterizes the small business stratum tends to sever easily the ties between specific innovations and particular small businesses. This, in turn, diverts our attention from the fact that, in general, compared to large firms, small firms tend to commit twice as much of their R&D funds to basic research, even though they allocate a smaller share of their workforce to R&D activities.

These complexities aside, the very process of new business formation is a broad avenue by which innovation flows into an economy. But the important point here is that the nation's diverse metro-regions differ greatly in their capacities for hosting new business formation. And these differences can be expected to translate into differences in hosting and harnessing technological innovation itself.

INNOVATION'S DIRECT INFLUENCE: R&D INVESTMENT PATTERNS

A second source of innovation is more direct. Here the focus is on the investments made by companies and government agencies to support R&D agendas. But how does the hosting of R&D activities lead to regional economic growth and/or adjustment? We must begin by realizing that R&D is not a homogeneous activity. Rather, it is an umbrella for diverse activities from the most fundamental exploration ("R") at the frontiers of -- and between -- pure science disciplines to the most targeted of commercial applications ("D"). And the differing motives and missions of the major players -- industry, universities, and the government -- increase this complexity.

University research centers are seldom directly identifiable as the source of commercializable products. Educated minds and the next generation of trained researchers are the critical -- if indirect -- contributions research universities make to a region's industrial and economic base. Knowledge at this stage is difficult to appropriate for the exclusive use of a host region. Any eventual regional payoff comes more indirectly, such as through active participation by area firms in building and maintaining excellence in area university research centers so that students who move through them--especially via graduate-level research and continuing education programs--are a value-added resource available for regional industry.

Industry and government R&D activities are more linear and calculating. Nonacademic scientists and engineers have typically sought to use pure and applied science strategically by building a technology base from which new products and services can be brought to the marketplace or to promote a larger national policy objective (e.g., national defense). But we unwisely assume that fundamental research (R) and development (D) are locked into some sort of fixed and linear sequence. Technology development can as easily lead to new science knowledge as vice versa. The quest for new commercial applications often so reorganizes what is known that it provides scientists with new directions for basic research by expanding and reworking knowledge bases, collapsing barriers between traditional science disciplines, and causing the rewriting of science textbooks and the updating of graduate course instruction. It is in these possibilities that we begin to glimpse the rationale for urging broader and multiple alliances between autonomous university research infrastructures and those of regional industry and government facilities.

DEEPENING DEPENDENCIES ON UNIVERSITY-INDUSTRY R&D ALLIANCES

Fewer and fewer U.S. corporations are performing their own basic research, preferring instead to target scarce resources to downstream development of commercial products. Ironically, this comes at a time when the linkage between basic science and technology application is changing (See Figure 1). For this reason, the industry base of a region needs continuous and easy access to the science and engineering (and liberal arts) talent being educated in local institutions. This relationship needs to be year-round, not just during annual recruiting campaigns. Ultimately, it is the health of the ongoing university-based research-centered instructional programs, not just their graduating classes, that is essential to technology-dependent firms and industries. Moreover, the ability to recruit talent educated and trained elsewhere will soon no longer be sufficient to compensate for the lack of constant and close relationships with top-quality graduate-level research programs.

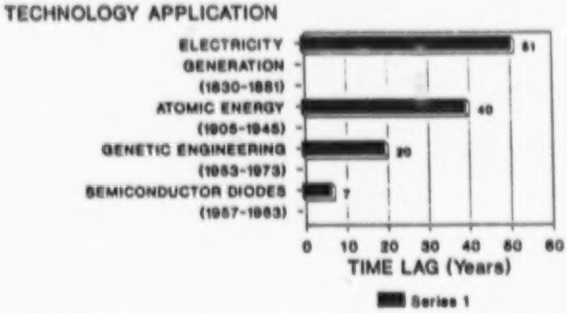
A region's economy is wisely viewed as a source of, as well as a destination for, R&D expenditures. This draws attention to two distinct -- if often overlapping -- R&D fund flows. The first involves funds attracted from outside the region, especially federal contracts and grants. The second involves the investments industries and universities are capable of making in themselves. R&D funds are widely regarded as **inputs** to a regional economy. And, as Figure 2 illustrates by highlighting federal funding of "basic" research, metro-regions differ dramatically in their capacities to attract monies at any or all stages of the R&D continuum. However, these same funds flows may also be seen as national investments which are drawn to excellence in industry and universities. These investments certify excellence; they do not create it. As such they may be regarded as **outputs** of the R&D and educational infrastructures already in-place in a region.

GAP-FILLING IN A REGIONAL RESEARCH INFRASTRUCTURE

For those regions whose lead research universities are public rather than private, we are recognizing the increased significance of the distinction between state-supported and state-assisted institutions. The levels of investment required to propel public-supported research universities into the ranks of world-class research and instructional centers -- and keep them there -- typically exceed the funding bases provided by public high education budgets. Such state funds only lay a foundation for greatness. It is up to the regions that host such institutions -- and potentially have the most to gain -- to provide the rest.

Figure 1.

SCIENCE-TECHNOLOGY TIME-LAGS
Shortening Links from Discovery to Practical Application



W.J. Broad, New York Times

Figure 2.

MEASURING A REGION'S "RESEARCH ENVIRONMENT"

	RESEARCH ENVIRONMENT = FEDERAL CONTRACT "BASIC" RESEARCH + NSF GRANTS + NIH GRANTS		PERCENT CHANGE
	FY 1985	FY 1982	1982-1985
Northeast			
New York	$495,679	$411,574	20.4%
Philadelphia	227,833	286,663	-20.5
Boston	669,706	642,311	4.3
Nassau-Suffolk Counties	55,704	49,676	12.1
Pittsburg	95,358	80,521	18.4
Newark	15,721	16,673	-5.7
Buffalo	28,751	31,340	-8.3
Hartford, et al.	42,898	41,016	4.6
Midwest			
Chicago	$196,156	$177,991	10.2%
Detroit	31,670	31,478	0.6
St. Louis	87,149	116,248	-25.0
Minneapolis-St. Paul	110,860	75,333	47.2
Cleveland	58,702	52,949	10.9
Milwaukee	18,331	16,385	11.9
Cincinatti	45,730	31,396	45.7
Kansas City	16,715	16,353	2.2
Indianapolis	4,114	3,150	30.6
Columbus	60,154	46,101	30.5
South			
Washington, D.C.	$285,072	$356,685	-20.1%
Dallas-Fort Worth	153,232	59,603	157.1
Houston*	N/A	N/A	N/A
Baltimore	183,910	146,311	25.7
Atlanta	65,610	41,442	58.3
Miami	34,851	28,728	21.3
Tampa-St. Petersburg	5,740	4,346	32.1
New Orleans	30,139	27,968	7.8
San Antonio	42,000	35,573	18.1
Fort Lauderdale-Hollywood	948	1,431	-33.8
West			
Los Angeles-Long Beach	$382,283	$314,944	21.4%
San Francisco-Oakland	405,036	209,522	93.3
Anaheim, et al.	73,049	32,368	125.7
San Diego	286,278	234,672	22.0
Denver-Boulder	107,791	60,297	78.8
Seattle-Everett	203,077	136,936	48.3
Riverside, et al.	10,874	10,396	4.6
Phoenix	11,794	9,791	20.5
San Jose	222,796	147,562	51.0
Portland	25,972	20,027	29.7
Sacramento	38,174	29,572	29.1

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* The major source of contract R&D for the Houston area is NASA, which does not report R&D disaggregated by stage.

TECHNOLOGY TRANSFER BETWEEN INDUSTRY AND UNIVERSITIES: A STUDY OF THE UTILIZATION OF FOURTH-GENERATION LANGUAGES IN MAJOR CORPORATIONS AND EDUCATIONAL INSTITUTIONS

Jeretta Horn Nord*, Mary Lisa Miller+, G. Daryl Nord*,
Richard A. Aukerman*

ABSTRACT

Industry's involvement with the fourth-generation of software technology is considered a critical component for effective curricula development, revision, and implementation. This study investigates the extent of utilization of fourth-generation languages in major corporations, specifically Fortune 500 companies, and American Assembly of Collegiate Schools of Business (AACSB) accredited institutions. It further identifies relationships which exist between industry and education regarding the usage and applications of 4GLs.

INTRODUCTION

The development of fourth-generation languages was signaled by a need to reduce software maintenance, cost, and time (ref 1). It has been suggested that maintenance and documentation may be reduced by as much as 70 percent through fourth-generation language implementation (ref 2). This reduction results in an increase in productivity and a decrease in cost. Intense competition, increased user demands, and hardware enhancements have spurred both industry and education into implementing and utilizing 4GLs. Although the review of literature revealed that fourth-generation usage is prevalent and will continue to increase, the described study was conducted to examine more fully the extent of 4GL utilization in major corporations and educational institutions.

RESEARCH DESIGN AND METHODOLOGY

Data reflecting fourth-generation's industrial impact on current educational practices and programming technique were gathered from questionnaires sent to two populations. Accredited members of the American Assembly of Collegiate Schools of Business were identified as the first population. Membership in this population group consisted of

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247 institutions. Fortune 500 companies were identified as the second population. Information was gathered from senior systems analysts in these companies so that the changes resulting from fourth-generation language inclusion could be evaluated and related to the changing curricula at the university level.

The AACSB questionnaire was designed to collect data specifically relating to four areas: (1) demographic data; (2) current programming practices used as a result of fourth-generation language utilization; (3) fourth-generation language characteristics, uses, or results being incorporated into information systems classrooms; and (4) types of instructional techniques used as a result of fourth-generation language incorporation into the curricula.

The questionnaire sent to the industrial Fortune 500 senior systems analysts was designed to parallel closely the AACSB questionnaire. The parallel design was used to gather data concerning four areas: (1) demographic data; (2) fourth-generation languages' effect on current industrial design practices; (3) identification of the most and least beneficial fourth-generation language characteristics, uses, and results; and (4) instructional practices used in industry.

There were 120 total respondents (48.59%) to the questionnaire sent to AACSB institutions while 169 (33.8%) of the Fortune 500 companies responded. The responses from both populations were used to identify response frequencies, response percentages, and a comparison of the frequencies of selected items from the AACSB and Fortune 500 populations.

RESULTS

Findings indicate that over 75 percent of the major corporations responding utilize fourth-generation languages to some extent within their organizations. Approximately 40 percent of those corporations using 4GLs have incorporated this new generation of software within the last three years, while 60.5 percent have used 4GLs for three years or more.

As indicated in Table 1, a wide array of fourth-generation languages was listed as 4GLs currently in use; however, FOCUS received the most responses. As indicated in Table 2, prototyping was reported as the primary application or use for fourth-generation software in responding corporations.

Table 1 Languages currently used in Fortune 500 Companies

Language	Frequency
FOCUS	45
IFPS	28
NATURAL	15
NOMAD	15
EXPRESS	14
RAMIS II	13
IDEAL	11
ADS	10
MANTIS	9
POWERHOUSE	6
SYSTEM W	5
QTIME	1
SPECTRA	1

Table 2 Primary Use or Application for 4GL Software

Use/Application	Mean
Prototyping	4.35
Application Gen.	4.05
Nonprocedural Prog.	3.81
End User Prog.	3.83
Automated DD	3.94
Maintenance Red.	3.94
Data Modeling	3.71
Decision Sup. Sys.	3.58
Documentation Aut.	3.61
Aut. Des. Tools	3.39
Security Features	3.50
Training Time Red.	3.39

(5-Most Beneficial -- 1-Least Beneficial)

Similar results indicate that 78.4 percent of responding AACSB accredited educational institutions have included fourth-generation languages into their curricula through existing courses, new courses, or a combination of the two. Table 3 gives frequencies and percentages for responses regarding 4GL incorporation into educational curricula.

Table 3 Fourth-Generation Language Incorporation

Curricula Placement	Frequency	Percentage
Existing Courses Only	61	52.6
New Courses Only	8	6.9
New and Existing Courses	22	19.0
Has Not Been Included	25	21.6
Missing Values	4	

When incorporated into an existing course, the Management Information Systems course was reported most often as the course used to incorporate 4GL concepts and instruction followed by Database Concepts and Systems Analysis and Design.

The majority of respondents indicated that more than one language was currently included in their curricula with IFPS and FOCUS receiving the most responses. Responses to this survey item are shown in Table 4. Table 5 reveals findings from educational institutions indicating that 4GLs are believed most beneficial for Prototyping, Application Generation, Nonprocedural Programming, and Decision Systems.

Table 4 Languages currently incorporated in AACSB Curricula

Language	Frequency
IFPS	39
FOCUS	23
NOMAD	6
NATURAL	5
SPECTRA	5
RAMIS II	4
SYSTEM W	4
ADS	3
IDEAL	2

Table 5 Primary Use or Application for 4GL Software

Use/Application	Mean
Prototyping	4.3
Application Gen.	4.25
Nonprocedural Prog.	4.14
End User Prog.	4.08
Automated DD	3.59
Maintenance Red.	3.42
Data Modeling	3.54
Decision Sup. Sys.	4.14
Documentation Aut.	3.48
Aut. Des. Tools	3.55
Security Features	2.88
Training Time Red.	3.51

(5-Most Beneficial -- 1-Least Beneficial)

CONCLUSIONS

Although slight differences were apparent between AACSB institutions and Fortune 500 companies, the majority of both respondent groups have implemented, utilized, or taught fourth-generation languages to some extent. FOCUS and IFPS were the most often cited languages by both AACSB institutions and Fortune 500 companies with Prototyping reported as the most beneficial application or use for 4GL software. Based upon the evidence of this study which reveals the infiltration of 4GLs in major corporations, it is imperative that educational curricula be evaluated and updated on a continuous basis to keep pace with industrial software technology.

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THE INTERACTION OF INDUSTRY AND HIGHER EDUCATION - THE SCOTTISH EXPERIENCE

Howard Moody*, Alastair Macpherson+

ABSTRACT

Higher education in Scotland is increasingly adopting a corporate role, as producer, product developer, marketeer and entrepreneur. The traditional strengths of Scottish education and an advanced industrial community have combined to create a flourishing knowledge environment and a diversity of relationships of benefit to both partners.

INTRODUCTION

Although it is only in the last thirty years, that the importance of links between education and industry has been formally recognised and the appropriate liaison framework put into place in the UK, the concepts of science park, academic director or spin-off company are not new. Glasgow University provided James Watt with an incubator unit to pursue his perfection of the steam engine. A Professor from the same University was a founding partner of Barr & Stroud Ltd, a world market leader in optoelectronics, in 1888. Lord Kelvin, the Victorian polymath, combined his Professorship of Natural Philosophy with a directorship of Kodak; he also ran his own company.

These examples of early academic/industry links have another feature in common. They are Scottish. Although compared with the United States and Germany, British higher education has been relatively slow to respond to the new industrial challenges - the UK technological Universities were only founded in the 1960s - within the UK, Scotland has adopted a pioneering role from the first Chair of Engineering to Europe's first Research Park. Edinburgh University created a chair in Technology four years earlier than the first recorded use of the word in the Oxford English Dictionary.

For a number of reasons, Scotland is well placed to demonstrate the scope, diversity and quality of the academic partnership with industry. Historically Scots have always placed great value on education; until the 1820s, Scotland had four Universities while the rest of the UK relied on Oxford and Cambridge. Admission to Scottish Universities was more open and the range of subjects taught, especially within the scientific and engineering disciplines, considerably greater. In addition, Scotland pioneered the truly technological institutions of learning, which were also open to the working man. The country's natural resources of coal, iron and deep water gave it pre-eminence in the first Industrial Revolution and laid the foundations of the economic base which today encompasses health care, electronics, energy and advanced engineering. The very geographical compactness of the country, whose industrial and academic heartland is roughly the same size as Greater Boston, has helped to foster a multi-disciplinary approach and close, informal relationships.

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THE SCOTTISH CONTEXT

The framework of the Scottish relationship is created round 8 Universities and 70 Colleges including 5 higher technological institutions, similar to the English Polytechnics. Four of the Universities date back to before 1600: the others were founded in the 1960's although Heriot-Watt and Strathclyde had previously long pedigrees as colleges of technology. Together, the Scottish Universities produce more graduates per head of population than any other country in Western Europe, around 15750 a year. Specific research specialisms range from artificial intelligence to bioengineering; in general, key overall strengths reflect the pattern of local and international market demand in areas such as health care, electronics and offshore engineering.

One example of the quality of the Scottish knowledge environment is the significant role that it has played in the attraction of international investment to Scotland from the USA, Europe and Japan. One in 6 Scots works for an overseas company. The portfolio embraces many of the Fortune 500 including IBM, Hewlett-Packard, Johnson and Johnson and Exxon and has been extended in recent years by companies of the stature of NEC, JVC and Mitsubishi, as the Japanese presence in Europe develops. The Scottish educational resource has proved a critical factor in the decision of international scientific business such as Syntex Research in health care and BBN Laboratories in software to locate their European research headquarters in Scotland.

THE NATURE OF THE RELATIONSHIP

In a sense, the higher education institutions are increasingly adopting a corporate role. They are product developers, producers, marketeers and entrepreneurs. Their primary and traditional role is as producers of trained manpower, of the next generation of doctors, accountants, engineers and managers. In response to demand, this role has extended beyond the degree and the doctorate to include continuing management and technological training. Almost equally fundamental is their research role as product developers and consultants with increasing emphasis being given in research funding to the application rather than the acquisition of knowledge. One spin-off from this role is the creation of new enterprises, which often retain close links with the academic parent body. Lastly, due to increasing demand from industry for specialist knowledge combined with pressure from Government to win industrial funding, the ivory towers are coming down, as higher education moves into the commercial marketplace.

The exact nature of relationships and delivery mechanisms are diverse and flexible in response to the particular market demand, whether the training of technicians for the semiconductor industry or contract research in drug delivery systems. The essential themes of production, research and enterprise are drawn together in specific initiatives. Corporate donations of equipment, for example, to Edinburgh University's Microfabrication Centre, the largest of its kind in Europe, benefit electronics students whose course work includes the design of an integrated circuit and allows researchers to develop specific applications. This allows donors to be associated with leading edge research and to put their name before a potential future market. The facility is also used by Wolfson Microelectronics Ltd, a University spin-off and leading semiconductor design house who in turn provide a service to both local and international clients.

THE DIVERSITY OF RELATIONSHIPS

Looking at the corporate roles of higher education in turn, the first role is that of producer of the skills, knowledge and outlook required to drive future generations of technology. Currently, it is estimated, that from a total population of just over five million, one in eight adult Scots is undertaking some form of further education. Each year, the University student population in electronics related disciplines is around 6000: a further 10000 are studying within the health care orbit and 4500 in engineering. The breadth and flexibility of the Scottish, four year Honours degree is sought after by employers throughout the UK.

Education and industry work hand in hand in the design of new courses. Industrialists sit on course advisory boards and academic staff carry out market research before launching courses. Industry and education also come together in special initiatives such as MIQUAl, a joint venture between the Scottish Development Agency, the Scottish Education Department and several electronics companies to meet identified potential skill shortages among semiconductor technicians. Again in response to demand, several Universities offer the 5 year BEng degree designed to unite the disciplines of engineering and management.

Both Universities and Colleges have also responded to the need for continuing career education, whether in terms of short, technology update courses or modular, part time degrees. Scotland, for example, led the UK in the introduction of both part-time and distance learning MBAs. Demonstration centres in areas as diverse as CIM and medical lasers allow company staff to gain experience and an objective viewpoint before investing in advanced technology. ITACS, the associate company scheme for post-experience training in information technology, brings together the University of Strathclyde, the Scottish Development Agency and 10 leading companies in an award winning initiative to deepen technical understanding and promote career enhancement.

Training is also an important secondary role of Scotland's research institutes, attached to Universities and Colleges but financially self-supporting. They operate as commercial businesses with corporate backing and provide industry with access to specialist knowledge through contract research, training and information resources. They include the Institute of Offshore Engineering, the Turing Institute, the Institute of Computer Aided Engineering and Management, the Centre for Medical Education and the Artificial Intelligence Applications Institute (AIAI). Founded in 1984, AIAI is a gateway to a research concentration of 200 staff in artificial intelligence, a concentration which is exceeded only by Stanford and MIT. Its clients include GEC, Rolls Royce and ICL.

Scottish Universities and Colleges are also creators and generators of enterprise through spin-off companies founded by academic staff whose research has opened up commercial opportunities. In Scotland, products reaching international markets through this route are as diverse as industrial lasers, biotechnically produced soy sauce, diagnostic kits, ultrasonic transducers, Protein A, large scale data handling equipment and thermo-electric generators. Many children retain the support of their academic parent through location on an adjacent science park, through seedcorn capital from a University technology fund or through an academic representation on their Board.

Deductive Systems Ltd, a software development house specialising in advanced knowledge management products, brings together many of the strands of the joint benefits of academic/industry relationships. It was founded in 1986 following a dialogue between two senior personnel from Metier Management Systems Ltd who were seeking to identify a capability in generic associative data models. They found it in a research team working on a major project funded under the UK Government Alvey initiative. The dialogue resulted in a new company located on the West of Scotland Science Park whose venture capital backers include the University Kelvin Technology Fund. The pattern is repeated in Bioscot Ltd, a joint venture between Edinburgh and Heriot Watt Universities in the application of biotechnology to animal and plant health.

Higher education has traditionally suffered from the British disease of focussing on technical innovation and forgetting the market. The last twenty years have, however, seen significant moves by Universities and Colleges to break down the barriers of lack of awareness, fear and misconception that at one time made industry reluctant to tap the source of knowledge and practical help on their doorstep. Scotland again was a pioneer in the setting up of industrial liaison offices and this activity is now extending into new areas such as the promotion of joint exploitation of the massive EEC research budgets by European companies and their academic counterparts and the marketing of University consultancy to help to set up the research infrastructure in China. Specialist research and training units market their services through promotion, seminars and most importantly by going out and talking to industry on its home ground. Scotland has also combined its support of advanced technology and its awareness of the need to reach the market in the creation of a unique database of University expertise which is accessed by companies throughout the world.

CONCLUSION

There is much still to be done especially in the new, post-1992 environment and given the acute shortage of young people coming into higher education over the next few years. As the Scottish experience shows, however, relationships between industry and higher education can be close, challenging and mutually rewarding. They are also supported by the public sector especially through the Scottish Development Agency which acts as a catalyst in forming new linkages and in supporting their growth. In essence, industry education links are like any relationship; they are about people working together to achieve mutual goals.

MAKING THE PARTNERSHIP WORK

Larry J. Blake*

ABSTRACT
INTRODUCTION

In preparing to discuss "Making the Partnership Work," I find a need to set the scene by reviewing the societal environment in which we are entering, past attitudes and relationships between education and industry, and future realities which must be addressed prior to discussing the true partnership. With that as a basis, I would like to present, in general terms, how to work together and to describe one institution's approach to the partnership.

THE CENTRAL ROLE OF EDUCATION

First of all, we need to understand the central role education will play in our society in the future, not a secondary, auxiliary, or complementary role, but the essential central role. In order to understand this, we need to talk of the coming of the "Knowledge Society." When I use this phrase, I am told we already have had many eras in our history which could be called the knowledge society, such as the age of enlightenment, the golden age of Greece, the age of the Pharoahs, and ancient China. However, these eras were much different inasmuch as the advance in knowledge and learning was harbored with only a small (less than one percent) element of total society. In the Knowledge Society it will be critical for every individual to be primarily and continuously educated to his/her level of ability.

In the past, when an individual was unsuccessful in completing high school or college, we said, "Tough luck, you had your chance," and, recognizing there was a need for workers without a high school or college diploma, let them find their appropriate niche in society. Now that there are very few jobs for these individuals, society finds a need for them to be better educated, to be productive, as well as to minimize the social costs of unemployment, welfare, and crime.

In recognizing the increasing level of education required as society becomes more complex, I have, as a futurist for twenty-five years, stated that the machine now has a high school diploma and anyone who stops at that level of education will have to compete with a machine for a livelihood for the rest of their lives. Increasingly, the work that used to be done by engineering technicians in several areas is now done by robots. Thus, in some elements of our society, the machine has an associate degree and, if you wish to extend that on into the future, there may come a time when it has a baccalaureate, a master's, or even a Ph.D. It is now becoming clear that the vast majority of our citizens must be educated to a far greater level than has been considered acceptable in the past.

In summary, it is readily apparent that the level of education of

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all citizens must be increased, not only for benefit of the individual, but for society, as well. We must also recognize that, contrary to life's three phases cited below, "perishable education" has made a process of continual education throughout an individual's life mandatory in order to avoid obsolescence as a productive member of the workforce and as a participating citizen in society.

PERCEPTIONS

Another element of our current scene that we must establish concerns the past attitudes of educators versus industrialists and vice versa. Until recently, it has been common for professors to be highly critical of the "inhumane" bottom line attitude of those in industry who, they felt, treated human beings as numbers within the equations resulting in profits. On the other hand, those in industry saw professors and educators as wooly-headed, ivy-bound individuals who had never worked a day in their lives and had no understanding of the real world.

Although unreal, these attitudes could be tolerated in a society in which one could divide his/her life into three phases, namely: education in early life, work in middle life, and, hopefully, retirement at the end. It was also accommodated in a society in which the time-lag between discoveries of research and their implementation in society could be measured in decades. It is no longer tolerable when that time-lag is changed to years and even months and obsolescence of acquired knowledge is measured in years.

THE KNOWLEDGE INDUSTRY

A new reality facing us is that the "knowledge industry" has rapidly become a wealth-producing primary industry. Most economists consider the wealth-producing industries as those with primary extraction and secondary and tertiary value-added industries. Most all other industries are lumped into the non-wealth-producing sector of the service industries. In western Oregon, examples would be the primary extraction of the timber industry, secondary processing into lumber and tertiary processing into doors, windows, etc. But today, for instance, one can write a software program using only knowledge as an ingredient and create wealth through its sale.

WORKING TOGETHER

With that as a background, we can now start to see how we might work together recognizing that, in growing separately, we speak different languages. I compare this to an American industrialist working with his Japanese counterpart in an international partnership. Each has significantly different methods of operating which each partner must understand in order to cooperatively work out a "translation" utilizing the best of each system.

Although education is not quite as foreign as Japanese, nevertheless, our management styles, measures of productivity, value systems, and even descriptive languages are different. We must now start merging our languages and our processes for mutual understanding. In accomplishing this, I prefer to communicate with my fellow educators through the redefinition of our three basic goals, namely: teaching, research, and public service, but including within them terms of the marketplace.

In "teaching" we need to use the term human resource development and to recognize the changing needs of our environment, particularly in the economic sector with regard to pre-employment education and, increasingly, continuing education.

In the "research" sector, we need to continue to work with basic research, but increasingly develop applied research involving the research professor as entrepreneur, sponsored and co-sponsored research, technology transfer, and industrial partnerships.

With regard to "public service," this definition needs to be extended to include such things as assistance to small business and entrepreneurs through small business development centers, business incubators, etc.; through the provision of demographic and other data services to elements of government; and to service on economic development agencies and task forces by college personnel at the local, regional, state, and national levels.

ONE INSTITUTION'S EXAMPLE

As an example of one small institution's efforts to fully participate in economic development, Oregon Institute of Technology, the only accredited polytechnic in the Pacific Northwest, has initiated the following efforts, most of them within the last five years.

In the teaching, or human resource development area, Oregon Tech has effectively utilized industrial advisory committees throughout its forty-year history gaining advice regarding curricula currency, laboratory equipment, graduate preparation, and faculty qualifications. As a result of this close tie with business and industry, Oregon Tech boasts a 97% graduate placement rate for the past five years, a figure which we believe to be the highest in the nation and well over a 90% placement rate for several decades.

Although located in a small city 280 miles from Portland, the state's metropolitan center, when business and industry indicated a need for Oregon Tech programs in that area, an extension campus was established five years ago in cooperation with Portland State University and local community colleges. The extension now enrolls approximately 200 students, most of them from business and industry. Wherever a need is expressed for short-term workshops and seminars related to Oregon Tech's programs in Oregon, those programs are conducted. We have also conducted many industry-specific programs on campus and are in the process of developing a training program using Tektronix software for the initial training of their clients' employees.

With regard to research, although only a baccalaureate-granting institution at the present time, OIT solicits client-based proposals for senior projects from a wide range of business and industry, utilizing thirty to fifty percent of those proposals suggested. Because of an international expertise in geothermal energy, an internationally-acclaimed Geo-Heat Research Center was established over a decade ago and continues to be in the forefront of this field. Currently, a superconductor research center is being proposed based upon contracts already received by several faculty in this field. One faculty member has been awarded several Small Business Innovative Research grants and another has just been awarded a grant from the state-based venture capital agency entitled, the Oregon Research and Technology Development Center.

Many senior projects, mostly in Industrial Management, but some in Computer and Software Engineering Technologies have assisted governmental agencies in improving their operations and services. Many of these are funded through the federal program of the Small Business Institutes. The campus-based small business development center provides short- and long-term counseling for over two hundred business clients in any given year in addition to the many faculty who consult on specific problems for local and state businesses. The development of a small business incubator is in the final stages with funding expected by the local city, state, and federal economic development agencies.

Many faculty and administrators serve on local, regional, and state community and economic development committees/commissions. Specifically, the president was appointed by two different governors to the Oregon Economic Development Commission as well as the Oregon Commission on Futures Research, Oregon Center for Advanced Technical Education, and the local Klamath County Economic Development Association. Sensing a need for closer cooperation between local development authorities, he formed Team Klamath several years ago with representatives from the economic development agency, chamber of commerce, county, city, college, and tribal governments.

In summary, as we move further into the Knowledge Society with a primary emphasis upon education as the major resource of a community, state, or nation, colleges and universities must recognize that they can no longer do "business as usual." In addition to a rapidly changing complex technological society, this insures that we must find new ways to communicate, coordinate, and work with government and private industry for the improvement of the quality of the university, the provision of a quality and contemporary program for graduates, and the enhancement of the economy of American society.

ABSTRACT

PROACTIVE EDUCATIONAL TECHNOLOGY

It's time to design PROACTIVE educational systems. A proactive system is one that initiates an interaction with it's user. This contrasts with systems that only interact when a user initiates the interaction.

Examples of proactive technology are abundant. Perhaps the simplest example of proactive technology is an alarm clock. An alarm clock certainly initiates the human-machine interaction. Voice synthesized automobile warning systems another example of a proactive technology.

Webster Model Technology School in St. Augustine, Florida is building toward a future. For example, we're designing network management software that will track students "lifetime reading list" and their "interests". The software will regularly review a students "interests" and his "lifetime reading list" and send him a message suggesting a new book he might like to read. These and other examples of proactive educational systems will be described.

DISCUSSION

R. W. Van Horn* and S. K. McDonald+

A proactive educational system is one that initiates an interaction with the user. By comparison, most edcational systems today are reactive. A reactive system is inactive until the user initiates an interaction. Simply stated, a proactive educational system approaches the user, it comes to you.

Examples of proactive technologies are abundant. Perhaps the simplest example of a proactive technology is an alarm clock. An alarm clock certainly initiates the human-machine interaction. Another example of a proactive technology is an automobile warning system that uses synthesized speech to tell you when something needs your attention.

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Educators at Webster Elementary, A Florida Model Technology School in St. Augustine, Florida, are working toward a future when the school's educational technology will be proactive. We are designing network software that will initiate a variety of interactions with students and teachers. Rather than have a computer system that just sits around waiting for someone to use it, we plan a system that approaches humans inviting interactions. Here is a rough sketch of a few of the proactive features we hope to build into Webster's computer system.

The first step in designing Webster's proactive system is the design of a comprehensive relational database. The database provides the system software with information upon which it can base its proactive interactions. Initially, the database will consist of three groups of files:

Library Books
Videotape Holdings
Videodisc Holdings
Software Holdings
Television Schedule
(Broadcast, cable, & Satellite)

Student Academic Records
Student Interests
Student Lifetime Reading

Curriculum Objectives (IMS)
Teacher Schedules

Network management software will systematically examine and compare Student Lifetime Reading Lists, Student Interests, and Library Holdings. Periodically the software will send notes to students suggesting books they might like to read. Such a note might read,

> Dear Wendy:
>
> I see you haven't checked out a library book in several weeks. I know you are interested in owls. The library just got in a new book titled,
> Owl Moon (ref 1)
> Drop the librarian an e-mail note if you want to reserve the book. Happy Reading!
>
> Your Friendly Computer

Two conditions will trigger the sending of these notes. The first condition is length of time since the last library book was checked out. The second condition is a match between Student Interest and Library Book (subject card). The software will look for books the students might be interested in reading that have not yet been read. Generically, one of these criteria is time based; the other is based on a match between two lists.

Using time as a condition upon which to base proactive computer actions provides many interesting possibilities. For example, the software might monitor the pace at which students master objectives. Teachers could be alerted to possible problems with notes like:

> Dear Ms. Holt,
>
> After a routine search of P. Smith's Academic Record, I noticed that the student's rate of accomplishment of IMS objectives has slowed markedly in the last two months. P. Smith was accomplishing 2.3 objective per month, but for the last two months he has not accomplished a single objective.
>
> If you would like a detailed analysis, select option #36 on the SET PROACTIVE FEATURES Menu.
>
> The Computer

Using the computer's list matching capabilities as a condition upon which to base proactive computer actions also provides many possibilities. For example, the computer could easily match keywords in the Teacher Lesson Plan file with keywords in the Television Schedule file and send teachers weekly notes suggesting educational television programming. Such a note might read:

> Dear Mrs. Wood,
>
> Here is a list of next week's educational television programming that seems to match your lesson plan topics:

YOUR L.P. TOPIC	SCHEDULED PROGRAM
L.A.: poetry	Nova: Three young poets Cable chan. 61, 300p. Wed
Soc. Std.: Explorers	Nat. Geo. Explorer: The Abocos: Were they Columbus's first stop? Satellite Chan. 217c, 8:45 am Thursday

Signed,
The Computer

The examples above show how either time or matches between lists might be used to trigger proactive actions. Suppose, however, that a user wanted to be able to tell the computer, "Help me remember to send thank you notes." Making this request, might cause the computer to enter me as a recipient of the proactive program titles, "Niceties" which randomly sends notes saying things like:

MEMO
TO: Fred
FROM: The Computer
Who was nicer to you today than anyone else? I have a nice selection of thoughtful cards in my files. Just type the person's name below and I will help you select a card

Send Card To:____________________________

To avoid a situation where the above becomes commonplace, the computer would need a wide variety of "Niceties" notes to send me as prompts. The computer would also need a wide selection of note cards that the user would not get tired of sending.

In the last example, we have in effect asked the computer to "coach us" into being more thoughtful. Designing proactive educational systems that assist are possible, but we can also design systems that encourage, prompt, coach, assist, teach, and even cajole.

Within three years, we hope to have proactive educational software in place that kind of things described above. If you know of existing proactive software from which we can learn, please contact us at Webster Elementary School.

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AN INSTITUTE FOR BETTER SCHOOLS: USING TECHNOLOGY TO ENHANCE INSTRUCTION

Al P. Mizell*, Joseph D. Randazzo*, and Stephen Margulis°

ABSTRACT

A consortium of three public school districts, a community college, and a university lab school has been proposed to use technology to improve instruction. The use of the Education Utility Service will provide each school with a minicomputer networked to a series of 30 workstations for each instructional team of four faculty and 100 students. Software will be obtained online from the central server in Vienna, Virginia in the evenings and stored for later use within the schools. Online communication between faculty, classes, and students will add significantly to the value of the system.

INTRODUCTION

The state of Florida, under the leadership of the Commissioner of Education, has encouraged the formation of partnerships of schools, colleges, and universities across the state to explore ways to use technology to improve the instructional process. The South Florida Education Center/Institute for Better Schooling (IBS) is a consortium of the Broward, Dade, and Monroe County, Florida Public Schools plus Broward Community College and Nova University. IBS submitted a proposal to the State of Florida to organize a group of model schools to use technology to enable them to realign and rebuild the curriculum, instructional practices, and administration of instruction in their schools.

PROJECT OVERVIEW

This project is known as Project Best (Better Schools Through Technology). The ideal that the BEST Schools Project and its participating schools are striving to achieve is visualized in the following excerpt from a scenario that appeared in an Esquire Magazine article by George Leonard. Although it is not an exact description of this project, it helps illustrate what can be done to better meet the individual needs of each student and to match instruction to individual learning styles.

> Students arriving at Jefferson Interactive Learning School go directly to the Learning Plans Center, a large room crowded with banks of computer display screens. Each student takes a seat at a vacant screen and places his or her right thumb on a sensor panel. A holographic scanning device identifies and checks in the student, calling up his or her learning record for inspection. The student commands the computer to display a review of the previous day's

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accomplishments, or, if desired, the previous week's or month's or semester's work record. The computer highlights any area that needs special attention.

This BEST Schools' Project will utilize the Education Utility developed by Jack Taub, who is well-know as the creator of the Source. The Utility is a total systems approach to computerization of the classroom and the school, to provide educational courseware, software, data bases, diagnostic and management tools in an electronic network to participating schools. The Education Utility offers a library of digitized educational programs, selected and paid for on a per use basis. Teachers can use the Utility to plan, diagnose, prescribe, monitor and test the learning of each student. Each student will use computer terminals linked to the teacher's computer, which can provide customized sequential instruction to each terminal. The teacher's computer is linked with others in the BEST Schools network, which is in turn linked by satellite uplink from Nova University's campus in Fort Lauderdale to the Education Utility's mainframe in Virginia.

The Education Utility is described by Teresa Middleton (ref 1):

> The Education Utility--called that because Jack Taub, its creator, sees it as a source as basic as the electricity or gas that flows through our other utility lines--is a system that seeks to integrate computer and video technologies as it delivers a wide variety of instructional materials to the teacher in the classroom through telecommunications technology. Put together by Taub's National Information Utilities Corporation (NIU) of Leesburg, Virginia, the Utility has four key components: (1) a repository of software, databases, and other instructional materials stored in its computer center in Virginia; (2) a distribution system, or network, to send materials through telecommunications carriers to state switching centers or directly to the school site; (3) a computer/controller at the school where the materials are temporarily stored for use by teachers, administrators, and students; and (4) computers and other equipment in the classrooms that can then access materials directly from the school's computer controller.
>
> The most important aspect of the Education Utility lies in its capacity to house and make instantly available electronically a wide array of instructional and management materials. These materials are held in the Utility's repository until they flow to the school on request. Each student's desktop computer could conceivably run a different program at the same time. The bank of instructional materials stored in the Utility will be constantly updated and expanded as new items become available and as users --particularly teachers and administrators--specify their needs and register their complaints. Users can provide feedback through messages sent via electronic mail; however, a more immediate impact will result from the actual use of

> the materials.
>
> The system will be constantly metering (or counting) the use of each item requested and will be able to run checks on how often an item is requested, at what grade level, etc. If an item goes unused, the software developer will know that something--content, level of difficulty, ease of access-is wrong, and indeed might want to initiate a request to teachers, via electronic mail, asking them to detail the problem and make suggestions for improvement.
>
> In addition, using the Utility's electronic mail system, teachers and others will be able to communicate with each other, with parents, with homebound students, and--as the system expands--with people in other countries, sharing information and ideas."

In this project, four schools (two elementary, one middle, and one high school) have been selected in each of the three counties (Broward, Dade, and Monroe). Broward Community College selected several subject areas (art, math, and reading/writing), on all three of its campuses. The University School of Nova University (grades K-12) will be involved. A team of four teachers and approximately 100 students will work together at each grade level. They will have a set of 30 computers connected to a server from the Education Utility available to their team. Teachers will be connected by electronic mail. They will be able to telephone a local number to connect to the system at night to search for digitized software that matches specific learning objectives. They can then reserve that software for delivery into their local server overnight so they can preview it at school the next day. If they can't locate appropriate software, they may elect to create their own programs. Successful software, developed by the teams, will be placed on the system for use by other teams as desired.

STRATEGIES

To make this project work as a model for other schools to use, the following goals were identified. The BEST Schools Project will attempt to:

1. Provide access to a quality educational experience for all children in the participating BEST schools.
2. Meet individual learning needs and styles.
3. Provide a larger number and variety of information resources than traditionally found in schools.
4. Improve curriculum planning, implementation, and alignment.
5. Provide comprehensive, fully-integrated tools for instructional management.
6. Provide tools for effective school management.
7. Strengthen the relationship between the schools and their community.

Project methodology will involve intensive training for teachers and administrators in the use of computers, surveys of courseware and software, and most especially, a thorough exploration of the use of technology in the domains of human learning, pedagogy, and school administrative practices.

The first year of the project is being devoted to training the first set of participating teachers and administrators, installing the Education Utility and computerized classrooms, and surveying curriculum materials and instructional software. During the second year, the Education Utility and computerized classrooms will be implemented in half of the grades and training will begin for the teachers of the other grades. During the third year, all grades will be involved in the project.

By the third year, the project will begin to train teachers to implement the Developmental Non-Graded Approach to Learning. Upper level grades will use an interdisciplinary approach to specified courses, such as mathematics and science. The college staff will also undergo training in year one and they will implement the project in year two in remedial reading/writing, math and science.

The role of computer technology in the administrative setting will be tested using the Education Utility to monitor student achievement, gather and report statistics in the essential areas, and to pool the data for external reports. The project will share its outstanding educational practices, courseware, and software among the consortium members and may license other schools to use these materials to help offset project costs.

COST

The project will be evaluated by a team of outside evaluators. The annual cost of the project will vary but it will be approximately $5,500,000 per year for a period of five years. Each district will contribute approximately 1/4th of the amount of money they request in the grant through in-kind contributions. After the project ends in 1994, each district will be expected to have assumed responsibility for continued funding from local funds. It is anticipated that use of the Utility by the community will generate revenue for the schools.

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CREATING A MODEL TECHNOLOGY SCHOOL - THE MAINLAND HIGH SCHOOL MODEL

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ABSTRACT

Educational delivery systems at the secondary level have not changed significantly in this century. The use of technology to assist teachers or students is not widespread. The Mainland High School model will restructure curriculum using technology, create a modernized media support system, and design a teacher management network which will facilitate communication and organization of clerical functions. Business partnerships will provide technical assistance in developing programs and training teachers. The success of the program will depend on the empowerment of classroom teachers to make decisions and to plan for implementation.

INTRODUCTION

The Florida Model Technology Schools Program is designed to investigate the most efficient and effective uses of educational technology. Each of the five schools in the program will be a high technology prototype devised for demonstration, research, and training. The Florida legislature enacted the Florida Model School Consortia Act (Ch. 228.0855, F.S.) "to encourage educators to pause and examine what are the best and most productive conditions for implementing instructional technology to enhance student learning and school management." Mainland Senior High School in Volusia County, Florida, has been identified as one of the five model schools which will meet the following goals established by the Florida State Department of Education:

1. To create a coalition of support for schools that joins schools with businesses, parents and post-secondary schools;
2. To provide environments with incentives for administrators, teachers and students to take risks in learning and teaching, to become more effective in their new roles and to welcome change with confidence in their ability to adapt effectively;
3. To provide students with hands-on experience to develop skills in utilizing technology as a learning tool;
4. To provide students with the opportunities through technology to practice the skills and knowledge learned throughout the curriculum;
5. To provide students with the means through technology to develop and exhibit mastery in their school work; and
6. To focus students' school work on the use of their minds to develop independence and responsibility for future learning.

THE INSTRUCTIONAL COMPONENT

Mainland Senior High School proposes to restructure its traditional delivery model to meet more efficiently and effectively the individual learning needs of students. William G. Katzenmeyer, Dean of the School of Education, University of South Florida, has suggested a model approach which addresses both the concerns of teachers and students. In his model

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a content teacher specially skilled at making large group presentations and demonstrations serves as a lead teacher for a team of classroom teachers. The lead teacher develops, with the assistance of a curriculum committee, a series of lively presentations which informs, excites, and motivates a group of approximately 100 students. Video disc players, slide projectors, and digital overhead projectors will be computer programmed to display the visual portion of each lesson. A remote controlled wiring system will allow the master teacher to orchestrate the lesson at the touch of a button. Lights can be dimmed or raised automatically as visual aids are projected onto one of three large ceiling-mounted screens. A pleasing visual presentation such as this would never be possible in a traditional classroom, but in a presentation center which can be shared by several subject areas, many courses can be infused with technology.

The model classroom for small-group instruction will be divided into two areas: a computer center and a traditional teaching area. Half of the students will work independently at the computer stations, while the remaining students receive individual instruction from the teacher. In these small groups (12-15 students), teachers will be able to discover conceptual and attitudinal problems of students sooner and implement strategies which promote increased opportunities for student success. Small-group activities and the computer-assisted instruction will reinforce and enrich the concepts presented in the presentation center. Teachers will be able to write individual learning prescriptions for each student and assess the student's skill development using the computer as a classroom management tool. The students will be encouraged to view learning as their responsibility and as a cooperative venture with the teacher.

Over the next five years, Mainland High School will develop model courses in Algebra I, Geometry, Biology, English 10, English 11, World History, American History, and Computer Education. These particular courses were selected because of their large, heterogeneous enrollments. Strategies common to all courses included are the following: team planning, scripted group presentations, individualized computer-assisted instruction, and intense teacher-student interaction in small groups. In addition to these model courses, all subject areas will have access to updated technology in all-purpose computer laboratories, with individual teacher computer stations in each classroom which can be used for demonstrations, and through equipment available to all teachers and students in the Media Center.

THE MEDIA COMPONENT

To support both the teacher and the student in the learning process, the Media Center will become modernized with electronic and CD-ROM systems to make accessing information as easy as flipping a light switch for electricity. College-bound students and their teachers will be able to do on-line searches such as "ERIC." Plans for the Media Center include as automated circulation and inventory system, 15 computer work stations for student use which can be used for research, remedial instruction, or drill for standardized test score improvement. Interactive video work stations will improve thinking skills and expand curricular concepts.

A well-equipped color television studio allows students to produce educational programs which can enhance the curriculum. Appropriate television programming available via satellite will be used to instruct students.

In addition, the existing microwave link between the Mainland High School television studio and the district instructional television broadcast system will be used to originate interactive instruction at Mainland for students in distant schools which have class enrollments too small to warrant offering the course.

THE MANAGEMENT COMPONENT

An additional area of support for the teacher will be the computerized management system which will connect teachers to each other and to the administration. Calculating grades, checking attendance, sending messages to each other, and creating individual reports of student progress for parents are clerical functions which will be easier for the teachers using a computer. Designing a networked system which will connect all teacher machines within the school and also connect the school's network with the district and state systems is an engineering challenge. A computer on every teacher's desk is the goal of the faculty as they plan a model management system. A central Florida software development company is currently working with school and district personnel to refine a software management system which will meet the identified needs of the Mainland teachers. The greatest benefit to the teachers from the computer management system is that it creates more time for instructing students or for planning more innovative ways to deliver instruction.

BUSINESS PARTNERSHIPS

A critical element in the planning and implementing of the Mainland Model School Program is a cooperative partnership with the business community. Industry has effectively used state-of-the-art technology for many years and has valuable expertise to share with educators as they explore effective educational practices. Currently partnerships for seeking funds and for providing consultation services have been formed with the following businesses and institutions: Private Industry Council, Brunswick Corporation, Educational Data Resources, Inc., IBM, Pacific Scientific Belfab, People's Gas System, Syscon Corporation, Universtiy of Central Florida, Stetson University, Bethune-Cookman College, University of South Florida, and Embry-Riddle Aeronautical University. The School Advisory Committee, comprised of parents and community members, is also a major source of support for the program. Enthusiasm will continue to spread beyond the school system itself as the district and school personnel aggressively seek additional business and educational partners to support the emerging program.

SCHOOL BASED PLANNING

Teachers are generally unfamiliar with the technology which is available to enhance instruction because limited school funds have restricted the purchase of many outstanding tools. The success of any program which proposes to infuse curriculum with technology is the involvement of teachers in planning for its effective use. Empowering the Mainland classroom teachers to be the key decision-makers in designing a "Model School" has been a key focus from the program's inception. Teachers have served on all planning committees with administrators and district level personnel. An all day retreat brought together the entire faculty for information gathering and decision making. The R.P.T.I.M. (readiness, planning, training, implementation, and maintenance) Model for creating successful change has been an effective and exciting means of involving teachers. School based facilitators have guided the faculty through brainstorming and consensus activities. Teachers have been surprised to discover that although their individual or departmental concerns might be different, when all school concerns are prioritized, there is strong consensus among colleagues.

Teacher training, selection of appropriate hardware and software, development of new instructional strategies, and continued linking with the community present many challenges to the Mainland faculty and to the Volusia County School Board as a whole. With a commitment from the faculty to work together, keeping lines of communication open as problems in implementation arise, the project will meet with success. Both Volusia County and Mainland High School have established reputations for creativity, innovation, and excellence in education. The Mainland Model will enable our school district to continue in this outstanding tradition. Through state-of-the-art technology applications, both students and teachers will be empowered to rise to the academic and economic challenges of the twenty-first century.

USING A COMPUTER ALGEBRA SYSTEM AT AN AUSTRIAN HIGH SCHOOL

K. Aspetsberger[1], B. Kutzler[2]

ABSTRACT

During the school year 1987/88 the computer algebra system muMATH and its underlying functional programming language muSIMP were used to design a computer science course for high school students at the age of 17 to 18. The course was held at the Stiftsgymnasium Wilhering in Upper Austria. The underlying ideas for the course are not specific to muMATH, this system has rather been chosen because of its availability on microcomputers. After shortly introducing into the problem domain we give a detailed description of the course and report on the obtained results.

INTRODUCTION

One of the starting points for considering the use of computer algebra systems in education was (ref 1). A first systematic discussion on this topic was held at a special session during the International Conference on Mathematical Education 1984, see (ref 2).

The integration of computer algebra systems into education will much more drastically influence the way of teaching mathematics than it was the case a couple of years ago, when pocket calculators became widely available. While the latter is used to perform basic numeric calculations, computer algebra systems allow to automate the solution of a much larger class of problems like, for instance, the symbolic solution of equations or the determination of derivatives and antiderivatives. This means an additional step towards a general *automation of tedious tasks*, enabling a *concentration on the creative parts* in the problem solving process.

Computer algebra systems are also a perfect means of teaching and learning *structured problem solving*, since the students are forced to decompose the problem into subproblems, to direct the solution of these subproblems to the computer, and to combine their solutions to the final solution of the original problem. More demanding is the *development of programs* that solve a whole class of such problems and that incorporate all these steps in their code. Finally, computer algebra systems can also be used to *improve the individual training* of the students. Such a system can serve as a tutor for students who perform badly, as a stimulus for good students, and can provide a perfect basis for a high-level computer-aided instruction system for mathematics education. A general discussion on how education could benefit from using symbolic computation software systems is (ref 3).

Most of the existing papers only contain proposals on how to integrate computer algebra systems without actually verifying their ideas in real courses. So far, only a few experiments at university level have been reported in the literature. At the University of Waterloo, the computer algebra system MAPLE is extensively used in undergraduate mathematics classes, see (ref 4). At the University of Hawaii, experiments with muMATH (a computer algebra system for PC's, see (ref 5)) in calculus classes have been made, see (ref 6). We have concentrated our interest to high school education. In (ref 7) we have reported on first experiments using muMATH in a high school. Based on the experience gained there, we have started a new effort that is described below.

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THE COURSE

This course was held at an Austrian high school (Stiftsgymnasium Wilhering, Upper Austria) as an elective computer science course with 1.5 hours per week. There were 10 students attending the course, all at the age of 17 to 18.

The goal of the course was to detect how far computer algebra systems can be integrated into teaching mathematics at high school level. In particular, our main interest was to obtain answers for the following questions:

(1) Will problem solving become easier for students when using a computer algebra system?

(2) Up to what extent can the system solve the problems posed in the text books?

(3) What are the requirements to students when using a computer algebra system?

(4) How far can a computer algebra system force students to stick to structured problem solving?

(5) Do the students recognize those parts in the solution of a complex problem that can be automated by combining basic routines of the system to programs?

The whole course consisted of three parts. In the first part, the students had to learn to use the computer algebra system muMATH, the second part was an introduction to its underlying programming language muSIMP, and in the third part the students had to extend muMATH by muSIMP routines for solving optimization and analytic geometry problems.

PART I – LEARNING TO USE MUMATH

Week 1–2: After a short excursion into technical details, e.g. how to start the system, how to load muMATH source files, how to break computations, etc., the muMATH package about rational arithmetic was presented (e.g. long integers, rational and decimal notation). The students had to apply the functions to simple problems given by the teacher. Typically, these were problems that could be solved by a single function call.

Week 3–6: Similarily, the muMATH package about elementary algebra was introduced together with the mechanism for controlling the application of transformation rules (control variables and special functions). The students had to apply the system to the examples in their text books, trying to obtain the results displayed in the corresponding solution appendices of these books. All intermediate steps required for obtaining the given solution had to be documented. As a matter of fact, the notion of simplicity, being of key interest here, usually is not treated in high school mathematics.

Week 7–10: In addition to applying the muMATH packages for equation solving as above, i.e. solving equations by a single function call, the students also had to solve equations by explicitly specifying the necessary transformation steps, letting the computer do only the simplifications of the left-hand and the right-hand sides. This is an example of how a computer algebra system can be used as a tutor by freeing the student from tedious and errorprone subtasks whose solution already has been taught earlier. The student can concentrate on the essential part of the problem type, thus learning to solve them by trial and error. This hierarchical way of using a computer algebra system to teach new mathematical subjects, in our opinion, is the best way of exploiting this new technology in the mathematics education.

PART II – LEARNING TO PROGRAM IN muSIMP

Week 11–14: The effects and the syntax of the most important language constructs of muSIMP were explained and demonstrated. Emphasis was put on recursive and assignment-free programming, which is the usual style for functional languages. The students had to write programs that solve simple tasks like basic set and list operations.

Week 15–18: For more demanding problems, like the realization of the Quick sort algorithm, they had to take care of structured programming. The final test example was the "Tower of Hanoi" problem.

PART III – EXTENDING muMATH

Week 19–21: The muMATH packages for doing calculus (differentiation, integration, determination of limits, etc.) were introduced and extensively applied to complex tasks like optimization problems and curve analyses. Emphasis was put on structured problem solving, i.e. a clear subdivision into subproblems and subsubproblems that can be solved directly by the computer.

Week 22–30: Based on the experiences gained during the former weeks the students had to work on the following two projects:

- Optimization problems: The students had to implement a function OPTIMIZE that solves optimization problems specified by a goal function and side conditions. The result of OPTIMIZE will be a tuple of values for a specified list of variables that fulfil the side condition(s) and yield the goal function to a (relative) optimum.
- Analytic geometry package: The students had to develop a package for analytic geometry in $\mathbb{R}^2$ and $\mathbb{R}^3$ that provides functions for basic operations like the scalar product or the norm of a vector, as well as routines for solving representative problems like transforming the equation of a line into normal form.

RESULTS

The results reported in this section are certainly specific to muMATH, but nevertheless most of them can be generalized to all existing systems.

Many students expressed their discomfort about the large number of commands. This is certainly due to the fact, that working with such systems requires a detailed understanding of the problem domain, the mathematical methods for its solution, and the computer algebra system's facilities, and also the ability of a combined application of this knowledge.

A similar discomfort was expressed by the students about the method of control variables for performing transformations. The way of entering and displaying expressions involving fractions and exponents was found to be very inconvenient by almost all students. We know, that this is a common problem for all computer algebra systems, but this unreflected opinion of the students confirm the utmost importance of a good man-machine interface for the general acceptance of these systems.[3]

The "mercilessness" of computer algebra systems forces students to clearly subdivide the considered problem into subproblems. Since muMATH can solve problems on a very high level, for most problems a one-level subdivision suffices. Thus, structured problem solving becomes not too complicated for students.

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[3] After completion of this work, the new computer algebra system DERIVE has been published by Soft Warehouse Inc. as the successor to muMATH. One of its main improvements is a menue-driven user interface that solves many of the above raised issues.

During a systematic application of muMATH to examples in text books, the students suggested the addition of several new features (gcd for n arguments, gcd for special multivariate polynomials, improvements for solving equations, approximation of numeric expressions containing roots, trig functions, etc.). Almost all of the simple training examples in elementary algebra and equation solving are covered by muMATH's capabilities.

Using muSIMP in a mere functional manner (recursive and assignment-free) turned out to be quite difficult for those students who had programming experience in BASIC. Similarly they could not get used to the top-down strategy of structured programming, since they avoided to refer to not yet implemented functions. It was very interesting, that the only student without any former programming experience found recursive, assignment-free and structured programming very natural.

The project on optimization problems was a big success, whereas the analytic geometry package project failed. In the latter project the students were not capable of determining a suitable set of functions that suffice for solving a representative class of analytic geometry problems, i.e. the design problem was too difficult for them. (This would have required a profound knowledge about the problem domain.) In contrast to that, the realization of the function OPTIMIZE was a mere implementation problem. Also the many concrete optimization examples the students had had to solve interactively during a former phase of the project helped them to formulate OPTIMIZE as a generalization.

CONCLUSION

The course described above showed that the use of computer algebra systems und functional programming languages can have challenging effects on education in mathematics and computer science at high school level. It also became clear that computer algebra systems must be improved and adjusted in a number of ways in order to be an appropriate teaching tool. The automation of the tedious tasks certainly will make it necessary to also drastically change the curricula, since routine work prevails in about 80 % of the problems treated in present-day teaching. Of course, this might also make mathematics much more demanding for the students. Thus, the use of such software systems in high school education must be carefully tuned.

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A COMPUTER-ENRICHED PRECALCULUS COURSE

Gloria Barrett*

ABSTRACT

The Mathematics and Computer Science Department of the North Carolina School of Science and Mathematics has developed materials for a new fourth-year college preparatory mathematics course. Funded by a grant from the Carnegie Corporation of New York, this applications-oriented course is developed around the following themes: mathematical modeling, computer and calculator as tools, applications of functions, data analysis, discrete phenomena, and numerical algorithms. The course is designed to encourage teachers to approach the teaching of mathematics in new and innovative ways. All of the themes that spiral through the course have an effect on the approach used in teaching, but none more than the use of the computer and calculator. "Tool" software for functions, data analysis, and matrices has been developed to accompany this course. Throughout the course, use of the computer allows students to concentrate on concepts rather than manipulations.

INTRODUCTION

In 1985 the Carnegie Corporation of New York awarded a grant to the North Carolina School of Science and Mathematics to develop a course for fourth-year high school mathematics. This course, called Introduction to College Mathematics, responds to the challenges posed by reports from the College Board, the National Council of Teachers of Mathematics, the Sloan Foundation, and the National Science Foundation to begin preparing students for their lives in the 21st century.

The course lays the foundation to support future coursework in mathematics including calculus, finite mathematics, discrete mathematics, and statistics, as well as providing an introduction to the mathematics used in engineering, the physical and life sciences, economics and finance, political and social sciences, and computer science. A primary goal of the course is to provide students with an applications-oriented, investigative mathematics course in which they are provided keys to understanding the technological world in which they live.

The computer is an integral part of the course, as its use allows students to focus on understanding concepts without becoming encumbered by extensive manipulations. Three software packages, Function, Analysis, and Matrix have been developed to serve as problem-solving tools. The software is designed to be used by the teacher for demonstration purposes in the classroom and by the students to solve problems.

The fabric of the course is woven with six spiraling themes that are treated with increasing depth and breadth at each exposure. The six

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themes are described below.

Mathematical modeling: A modeling approach is used for problems in geometric probability, to analyze sets of data, to introduce, motivate, and apply the various elementary functions, and for motivation and application of matrices.

Computer and calculator as tools: Technology has lessened the need for extensive computation using pencil and paper techniques. In this course, the calculator is used in calculations of arithmetic expressions and function values, in numerical algorithms, and as an aid in making conjectures. The computer is used for calculations related to functions and matrices, for exploratory data analysis, and for quick and accurate graphing. Empirical models are central to the course, and the computer is used to develop models from actual data through re-expression and curve fitting. The course content is based on the assumption that a single microcomputer is available for demonstrations by the teacher in front of the classroom. Since the accompanying software is written specifically for the course, the computer is used as a tool that serves the curriculum.

Applications of functions: The overall goal is to illustrate how functions serve as a bridge between mathematics and the real world it models. The focus is on understanding the behavior of the functions, with an emphasis on graphing, both qualitative and computer-aided.

Data analysis: The principal goal of data analysis is to draw information from data. A conceptual treatment is given to both resistant and least squares techniques of curve fitting. Techniques of data analysis allow the students to uncover what, if any, functional relationship exists between pairs of variables.

Discrete Phenomena: The traditional precalculus-calculus course sequence is based primarily on the mathematics of continuous functions. However, the analysis of many phenomena in which mathematics is applied requires discrete techniques. Among the discrete mathematics topics included in the course are finance, population growth, political apportionment algorithms, economic production, and Markov chains.

Numerical algorithms: The availability of computers requires that students be able to use numerical methods to solve problems for which no exact method exists or for which the exact method is beyond their ability.

The course encourages students to approach mathematics in new and innovative ways. Having a computer in front of the classroom during discussions enables a class to make conjectures, to check guesses and analyses, to explore "What if...?" questions, and to work with real data. These activities are invaluable contributions to the learning process.

THE SOFTWARE DEVELOPED FOR THE COURSE

Three software packages serve as problem-solving tools for the course. Each requires an IBM PC with 512Kb of memory and a color graphics adapter. The three packages are described below.

Function: This package provides support for graphing functions, locating zeros and turning points, finding points of intersection,and evaluating functions. The software can reference previously defined functions in defining a new function and supports the use of five parameters which can be used within the function definition.

Analysis: This package provides the tools commonly used in exploratory data analysis. Data sets can be saved to files for later recall. The software supports plotting data, transforming data, resistant line, least squares, and fitting model to data.

Matrix: This package supports many operations associated with matrix algebra and the simplex algorithm for linear programming. Matrices can be defined in terms of previously defined matrices.

These three packages provide the problem-solving tools that are relied upon in the written materials. Much of the syllabus cannot be taught well without the use of the computer. More importantly, we expect the teacher to serve as a role model by using a computer to explore ideas and solve problems during classroom lectures and discussions.

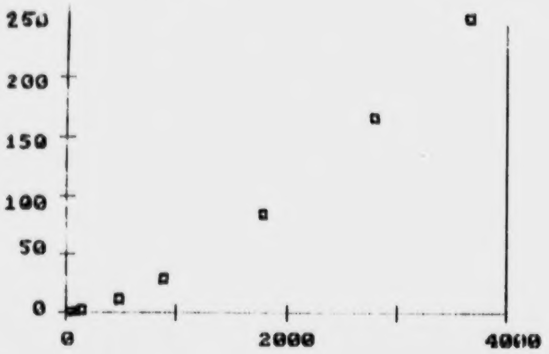
THE EXPANDED CURRICULUM

With the increased availability of computers and calculators that allow students to solve equations, graph functions, and manipulate matrices, we have recognized the need to redefine what we teach and how we teach it. Students should no longer spend weeks finding rational roots of polynomial equations, using algebraic manipulations to locate zeros and turning points of functions, and manipulating symbols to solve equations and inequalities. Instead, this time can be used to expand the curriculum and to increase our emphasis on those topics cited in documents such as An Agenda for Action (ref 1) and the working draft of the Curriculum and Evaluation Standards for School Mathematics (ref 2).

Throughout this course students use data analysis techniques to find empirical models for real-world phenomena. As an example, the data in Table 1 show the planets of our sun, their mean distance (x) from the sun measured in millions of miles, and the number of years (y) required for each planet to complete a revolution around the sun. The computer-generated scatter plot of these ordered pairs allows students to recognize that this relationship is not linear.

Table 1 Planet revolution data and scatter plot

Planet	x	y
Mercury	36.0	0.241
Venus	67.0	0.615
Earth	93.0	1.000
Mars	141.5	1.880
Jupiter	483.0	11.900
Saturn	886.0	29.500
Uranus	1782.0	84.000
Neptune	2793.0	165.000
Pluto	3670.0	248.000



Students draw on their knowledge of function characteristics and conjecture that the relationship can be modeled by a power function. If this theory is correct, the curvature can be removed by taking logarithms of both the x-values and the y-values. The computer can be used to perform these re-expressions and to graph the transformed data to determine whether the re-expression successfully linearizes the original curvature. Since the log-log graph in Figure 1 appears linear, the computer can now be used to find the equation of a line through the points (log(x), log(y)). Conversion back to original variables produces the mathematical equation that we know as Kepler's Third Law. As a final step, students can observe the model superimposed on the original scatter plot (see Figure 2).

Fig. 1 Scatter plot of re-expressed data

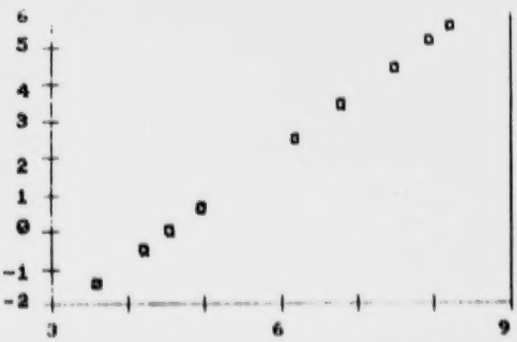
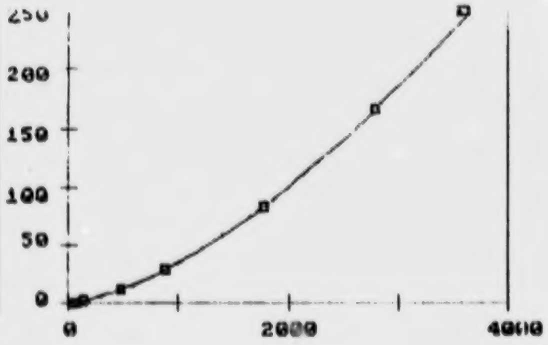


Fig. 2 Original data and model



AVAILABILITY OF THE MATERIALS

Portions of these materials and software are available through the National Council of Teachers of Mathematics. The series New Topics in Secondary School Mathematics includes materials and software for Geometric Probability, Data Analysis, and Matrices. Contact NCTM, 1906 Association Drive, Reston, VA 22091, (703) 620-9840. For information on the other materials, contact: Carnegie-Funded Project, c/o Jo Ann Lutz, NCSSM, 1219 Broad Street, Durham, NC 27705, (919) 286-3366.

Any opinions, findings, conclusions, or recommendations expressed through this project are those of the authors and do not necessarily reflect the views of the Carnegie Corporation of New York.

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BEYOND ENHANCEMENT - THE PLACE OF TECHNOLOGY IN MATHEMATICS TEACHING

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ABSTRACT

As we move into the 90's, we have available, not only devices for arithmetic computation, but also relatively inexpensive devices which can carry out manipulative tasks in algebra and calculus. Consequently it is necessary to review the content of mathematics courses at the upper school and early college levels and it should be possible to place more emphasis on teaching cognitive skills and also on communication and problem solving skills which have tended to be the poor relations in the last few decades.

In such an atmosphere, CAL must move from its position of being the icing on the cake of some of our mathematics courses to being an essential ingredient of many courses. Laboratory classes using CAL packages have formed an integral part of first and second year degree courses in Mathematical Sciences at Paisley College of Technology for a number of years. The unique contribution from this component of the course has been

(i) the use of graphical displays to bring the development of real mathematical intuition with the grasp of students;

(ii) the computational power available which opens up new possibilities with problem solving;

(iii) the opportunity to work in small groups which nurtures communication skills more effectively than was possible using traditional methods alone.

In the presentation, the authors will include illustrations of how programs of modest size used with accompanying worksheets can direct the student into genuine and worthwhile mathematical activity.

INTRODUCTION

Recent advances in computer hardware and software have made it possible to have a computer take over lengthy manipulative tasks in the fields of algebra and calculus; the effect of this on mathematics may well be as great as that experienced in the middle of this century when calculators became readily available. Then, the tedium was taken out of lengthy numerical calculations and as computation moved from desk calculator to computer, the scale of practical problems which could be tackled increased many-fold and new methods of solution of such problems were developed. As mathematics teachers, we must consider the consequences of the availability of computer algebra packages with regard to what and how we teach.

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COURSE CONTENT

Up to now, the criterion used in selecting topics for inclusion in courses at upper school and early college levels has been the usefulness or potential usefulness of the topic. An end point in the form of a qualified mathematician, engineer, scientist ... was held aloft and the earlier courses designed with the aim of producing this type of graduate. So, topic A which involved mastering a technique, for example differentiation, must be included in the first level course so that it can be used in the study of topic B at second level and so on. At worst, this resulted in early courses degenerating into uninspired, drill and practice sessions in which useful skills were acquired for later, more interesting tasks. No one could doubt that acquisition of manipulative skills in algebra and calculus will always be a part of the education of users of mathematics. Indeed, the techniques used are the end result of centuries of development and can, and will be appreciated for themselves alone by a number of students. However, we must address the problem of insufficient, mathematically motivated pupils coming through the system. We could liken the situation to offering a woodwork course in which the first year was spent learning to sharpen the chisels and then consider how many would enrol enthusiastically for the second level course.

Now that a possibility exists to alter the balance between time spent on acquiring manipulative skills and cognitive skills, care must be taken to ensure that the most efficient use possible is made of resources. Not so long ago it was assumed that exposure to Euclid would inspire a love of geometry, exposure to Shakespeare would inspire a love of literature and so on. Again this approach succeeded with the most able students but there can be no doubt that forced study of the masters, in whatever field, at the wrong time can have disastrous results. Instead of presenting the polished results of our mathematical inheritance, our aim should be to interest our students. A A Lyublinskaya (Ref 1) observed that a person who has abilities but no interest in an activity will produce less than one with a keen interest in the activity but with no striking abilities in it. This latent productive power must be released to give us the qualified manpower needed for the next decades.

If we accept that exciting interest in mathematics is the underlying aim of our courses we should consider next the skills and attributes which an individual or professional might expect to gain from his study of the subject. Some of these are:

(i) to be able to use mathematics and communicate mathematical ideas;

(ii) to be able to analyse and solve problems;

(iii) to be able to comprehend new ideas - change is inevitable and adaptability is essential;

(iv) to be able to investigate unfamiliar situations.

The acquisition of skills in mathematical techniques is essential but help is now on hand with the sharpening of the chisels, leaving more time for experience of the real job, that is for experience of normal mathematical activity and exposure to the excitement, arousal of curiosity, the satisfaction, even the companionship to be found in mathematics.

THE CONTRIBUTION FROM TECHNOLOGY

To effect a change to a curiosity-driven course would be extremely difficult using a traditional classroom approach. A mathematics laboratory component has been part of some of our courses for a number of years (Ref 2) and has been shown of great value in improving cognitive, communication and investigational skills in our students. Laboratory work is done with groups of two or three students working with prepared software on a microcomputer using a carefully designed worksheet and with a member of staff available to give advice if required. It is to this that we must look for the way ahead.

The difficulty in encouraging students to discover for themselves is that it takes so long; for example, to reach the idea of a derivative by evaluating successive approximations to a limit is time consuming and yet software which links the visual and computational components can, to a certain extent, allow the student to approach the concept as it was approached historically.

To illustrate the possibilities of this approach, consider a typical high school course on the parabola and the quadratic function. In Scottish schools, pupils learn about functions, turning points, axes of symmetry, solution of quadratic equations and the technique of factorisation. These are all sound topics which will be of great use in later courses! But, at the time these topics are introduced, will they excite interest in the pupils? Numerous books on popular mathematics are to be found on bookshelves, many including mention of the parabola but containing little, if any, discussion of the topics listed above. The "populus" seem more interested in the fact that a parabola is the path traced out by a projectile and in the focussing properties of the parabols, and why not? We are surrounded by reflectors, satellite dishes, to say nothing of our everyday experience of footballs, tennis balls etc. It would be argued that since we cannot use the properties of the tangent and normal until some calculus has been covered, the reflective properties of the conics cannot be studied till later. Since this property was known long before either Newton or Leibnitz lived, it must be possible to use the computer to simulate the kind of experiment which leads to knowledge of the properties of the focus. Not only can we now include some interesting properties of the curve but the pupil will have to use some of his knowledge of angles and equations of lines to prove his hypothesis. The use of the machine to simulate a situation and provide data from which a hypothesis can be formed, leaving the pupil to try to produce a general proof is real mathematical activity.

Even greater opportunities to use the computer in the classroom exist if we look beyond the topics selected for inclusion in school courses in recent years. For example, problems in combinatorics can be investigated by examining number patterns in Pascal's triangle, problems in probability by investigating random walks, problems involving loci by using computer animation, and so on.

CONCLUSION

In a recent Mathematical Association of America report on courses on discrete mathematics (Ref 3), the authors state that the topics to be covered are less important than the acquisition of mathematical maturity and of skills in using abstraction and generalisation. The computer has a key role to play in this area. As the increasing power of the computer releases us from routine manipulation and also provides the means by which we can offer our students a more genuine mathematical experience, it is essential that we press on towards the situation where no mathematics classroom is without at least one computer.

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THE STATUS OF TECHNOLOGY IN EDUCATION IN THE 24 OECD MEMBER COUNTRIES: DIVERSITY AND CONVERGENCE

P. Duguet*

ABSTRACT

Specific policies and strategies for introducing computers and related information technologies into the schools of the industrialised countries of the OECD differ, although common broad trends are apparent. In particular, there is a shift from 'restricted' policies intended to promote instruction in computer science and computer literacy towards 'comprehensive' policies designed mainly to increase the effective use of computer based teaching and learning across the curriculum. The real challenge confronting countries seeking to effectively harness the capacity of the computer for education is now seen as pedagogical, how can the technology be used to improve teaching and learning processes. Strategies for the development and use of hardware, software, teacher training, and evaluation must now be considered in light of this challenge.

INTRODUCTION

National, regional, State or local policies for introducing computers into schools in the OECD countries (North America, all European countries, Japan, Australia and New Zealand) have largely responded to pressures outside of education. The pressures exist in every country; they differ only in the degree to which they have influenced policies and strategies:

- Demands from the economy: the restructuring of the economy calls for new, technology related skills.
- Industrial interests: the introduction of technology in education complements and strengthens the development of the national microelectronics industry.
- Commercial pressures: manufacturers promote the introduction of technology in schools as part of marketing strategies aimed at increasing sales to business at to families.
- Social pressures: parents often take a lead in bringing computers into the schools and young pupils have bring with them an interest in computers and basic technological expertise acquired at home.
- Cultural dimension: the media frequently report on social and economic changes that appear to be driven by, and are associated with, information technologies.
- Political pressures: political leaders regard programs for introducing computers in schools, particularly for the purpose of computer literacy, as a good way to demonstrate a visible and concrete commitment to improvements in education.
- -- Technological developments: the progress in technology itself increases the range and speed of its applications while reducing its costs.

In response to these pressures, most OCDE Member countries developed ambitious and costly programmes in the beginning of the 80's. The programs differed in terms of their specific objectives and strategies of implementation. However, some common trends have emerge in broad policies, in broad strategies for implementation.

CONVERGENCE OF POLICIES

Trough the mid-1980's, OECD Member countries could be divided into two groups according to broad policies approaches. The first group consisted of countries which developed policies which could be called 'restricted'. The objective of these policies was to introduce the teaching of computer science into vocational and upper secondary education, as well as computer literacy for all students at all other levels of education. Australia, Austria, Belgium, Denmark, Finland, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway and most States of the United States were in this group. The following quotations reflect the objectives of all these countries: "To bring a high standard of technological awareness and skill to all Australian children" (Computer Education Program 1984-86, Australian Federal Ministry for Education and Youth Affairs, February 1984) or: "Basic education in information technologies for all pupils; advanced optional course in informatics; occupation related education in information technologies" (Bund-Lander-Commission for Education Planning and Research Promotion, Federal Republic of Germany, December 1984). The second group consisted of countries who developed 'comprehensive' policies intended not only to promote the teaching computer science or computer literacy but also and mainly using computers to improve teaching and learning. The most telling examples were probably Ontario (Canada), France and the United Kingdom as indicated in the following statements: "To develop computer related skills for participation in the work place and more generally, for participation in an information society; to improve the delivery of areas of the curriculum; to provide a technology to assist the learning of the individual, particularly through creative applications" (Ministry of Education of Ontario, 1982) or: "To initiate all students in computer science as part of general education; to make teaching and learning more effective; to review and update vocational and professional education; to use information technologies to innovate at all levels of education" (French Ministry of Education Program 1981 and the 1985 Plan Informatique Pour Tous) or: "To promote, within the school curriculum the study of microelectronics and its effects; to encourage the use of technology as an aid to teaching and learning" (English Microelectronics Education Programme 1981-1986).

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Towards comprehensive policies

Most OECD countries have moved towards these policies, either by changing the orientation of their programs planned some years ago, as in Italy (1985 Program), Portugal (The Minerva Plan 1985-1988), Norway (Programme of Action 1984-1988) and Spain (The Atenea Plan 1985-89), or by introducing entirely new Programs, such as in the Netherlands (The OPSTAP Project 1989-1992). In the United States, Bank Street College concluded on the basis of a 1985 survey that: "The focus of educational uses of computers has shifted from computers as objects of study to computers as tools for learning". A 1988 report from the Office of Technology Assessment of the US Congress reveals advanced developments in this area. Even in Japan where, for various reasons, resources for training students to the information society had been directed at vocational level, ambitious projects have been introduced since 1986 to develop computer based learning. If the trend is clear, there are still different views about the role of computers for improving teaching and learning and there are different stages of development across countries. Developments in the United Kingdom, in some states of the US, or in some provinces of Canada cannot be compared with developments in the Federal Republic of Germany, Austria, Japan or Sweden. Among the reasons accounting for the differences, two stand out: differences in the specific objectives of the educational systems and the way they work and differences in an array of cultural and sociological factors. But the trend towards comprehensive policies should be understood as a very important one. We know that the teaching of computer science or computer literacy does not modify the traditional methods and organisation of schooling. But as an integrated tool for learning, information technologies can have a profound impact on the learning process, on the content of courses and their relationship, on the role of teacher and on school and classroom organisation. Educational authorities in many OECD Member countries have begun to see that information technologies can be used as a lever to modernise or to bring about substantial change in their educational systems.

COMMON TRENDS IN STRATEGIES FOR IMPLEMENTATION

The main components of strategies for implementation are concerned with hardware, software, teacher training and research and evaluation .

Hardware:
Two major trends can be observed. The first is the adoption of nationally-manufactured computers in schools, as in France (Thomson, Bull); Italy (Olivetti); the Netherlands (Philips, IBM Netherlands); Norway (Scandis, Tiki); Portugal (Enner 1000); Spain (Computec XP) and the UK (BBC, RM and Sinclair). This trend is related to the broader policy objective of developing the national microelectronics industry. In addition, there is a related trend toward the establishment of a national standard in order to eliminate hardware incompatibility. Eighty incompatible types or computers have been identified in schools in the Netherlands (1985); 75 types in Norway (1982), and around 100 in Japan (1987). In March 1988, in Japan, eleven electronics companies developed a computer prototype for educational use based on the TRON operating system. The second trend is an increase in the number of machines (now reaching an average of 1 micro for 40 students in a number of OECD Member countries) and in the power of the machines as required by the new powerful software packages for learning activities or by professional tools such as word processing, spreadsheets or data-bases.

Software:
There is a considerable amount of educational software on the market today. It is estimated, for example, that there are now in the U.S over 10,000 available stand-alone instructional programs and between 1,000-4,000 in Australia, Canada, France, Italy or the U.K. The number of more elaborate 'integrated learning systems' is increasing as well, and the quality of all software has improved considerably. Although the vast majority of software aims at testing or teaching basic skills through drill and practice, perhaps 10-20 percent are designed to teach higher order thinking skills. Despite the improvements, all educators agree that the quality of educational software should be much better. In that respect, the trend in OECD countries is to set up agencies to review and evaluate existing software (sometimes to provide quality ratings for teachers and administrators). It should be noted that in most countries, these agencies have been created by the educational authorities. This is the case in Australia (National Software Co-ordination Unit), Canada (Database of the Council of Ministers of Education), France (Educational Software Commission of the Ministry of Education), Japan (Centre for Research on Educational Software of the Ministry of Education), the U.K (National Educational Resources Information Service, set up by the U.K Department of Trade and Industry) and the U.S with states initiatives (the San Mateo Microcomputer Centre in California or the Center for Instructional Computing in Florida); collaborative efforts among states such as the Software Evaluation Exchange Dissemination; or with the help of the Federal government as was the case for Microcomputer Software Information for Teachers.

Teacher training:
Teacher training is obviously the crucial issue to be addressed for successful introduction of computers in schools. In most OECD countries, programs have focussed their resources, firstly on the hardware provision, secondly on software delivery, and finally on teacher training. Even if this sequence tends to be reversed now, the situation remains critical: only a small percentage of teachers have had introductory courses preparing them to operate a micro-computer and to set up and manage the hardware available in the classroom. In the best cases, such as in France or the U.S, this percentage is, respectively, 25% (and 40 hours of training) and 30% (and 10 hours of training). For some specific levels of education, the percentage of teachers trained is far higher. For example, it is claimed that 95% of Danish upper secondary teachers have completed a 20-lesson course in educational computing at their schools. But in all instances, such introductory training is insufficient to

meet the new need: training teachers in the pedagogical uses of micro-computers. Very few teachers receive this type of in service education. Not only, is it complex and potentially costly to organise (e.g lack of time of teachers, lack of trainers), but little is known about how students learn, or just what they learn, when they interact with computer-based materials. A related trend has recently appeared in OECD countries: teachers are beginning to use a wide range of educational practices and strategies in their classrooms. As a result, there is an increasing tendency to regard teachers as 'researchers', working in their classrooms to analyse the actual effects of different software packages and experimenting with alternative ways of using them, often in co-operation with universities and teacher colleges. The best example of this approach has been given by Portugal.

Research and Evaluation:
In 1984, the OECD conducted a survey covering 122 universities in nine OECD countries pioneering in the field of educational technology. The analysis of responses showed clearly that the level of both human and financial resources devoted to research in this field was low. It is now recognised that the potential of computers for better learning, and for a better understanding of the related cognitive processes, will not be realised unless governments provide increased funding to research centres. Research is needed to demonstrate the **real effectiveness** of computers in enhancing the learning process. Investments in human and financial resources, as well as the pedagogical stakes in the broadest sense, have become too great for us to be satisfied with existing reports of evaluation studies, undertaken for the most part some years ago and which yielded ambiguous or inconclusive findings. Governments can no longer provide funding for second wave computer acquisition projects based solely on the **potential** effectiveness of computers. England (1987), Australia (1986), Scotland (1987), France (1986), Norway (1987) and more recently the United States (1988) have published interesting evaluation reports. But there is a need to go further, to build on the experience of pilot schools which have now reached the **critical mass** in terms of access to computers, quality curriculum-integrated software and teachers trained in the pedagogical uses of the computer. A good example of this urgent need is given by the decision of the UK to create a unit within the Ministry of Education and Science to supervise "a major policy-oriented research study to provide firm and consistent evidence of the effectiveness of the use of Information Technologies as teaching and learning resources".

CONCLUSION

In focusing actions on the role of computers in enabling improvements in teaching and learning, OECD countries confront the present problems of a lack of hardware in schools, a lack of quality software for use across the curriculum and a lack of appropriate training for teachers. It is probable that these problems will be solved because of the growing concern of governments and schools and because of the rapid development of the technology itself. But, one might reasonably imagine that in the next ten years every student will have a pocket computer. This will then imply a radical change in the use of computers in schools. For example, the software market would be a mass market in which successful programs would sell by millions. In the classroom as well as at home, students would be able to make rapid calculations, check the validity of a formula, look up statistics, review a lesson, type a report, take notes and communicate with other students or teachers. In this future, hardly a textbook would be published without a set of diskettes or ROM chips offering a wealth of examples, drill and practice exercises, simulation activities, relevant data bases, interactive concept exploration and hypothesis testing -- all organised and planned in keeping with an instructional strategy complementary to the content of the book. This vision implies that we are now in the midst of a transitory period and the most radical changes are still to come. The wisest thing to do, therefore, is to try to build a reasonable view of what is coming and to use the means now available -- teacher training, research and evaluation, all three focussed on the pedagogical uses of computers -- to help prepare our educational system for the inevitable changes which lie ahead.

INFORMATION TECHNOLOGY IN RURAL U.S. EDUCATION

By Victoria Williams

ABSTRACT

Rural schools in the United States face the multiple challenges of limited financial resources, well trained teachers, a changing economy, and the lack of population density necessary for developing sophisticated educational offerings. In this paper, we examine how information technologies -- namely computing and telecommunications -- can assist in approaching the problems. Finally, it is maintained that education is a particularly critical investment for rural America.

RURAL ISSUES AND ATTITUDES

When we mention rural school districts in this country, the emphasis is usually one of problems. However, there are some advantages in the rural district environment. These include:

-There is usually a high regard for the natural environment.
-There is usually a high number of intact families with children and a high allegiance to family values.
-Most districts, especially smaller ones, benefit from a high degree of interest in the school system.
-Sometimes the school district represents the main infrastructure of the area.
-There is a large degree of mutual assistance among rural people, including food and shelter.

There is a more challenging or negative side:

-Rural districts often do not have a sufficient tax base for their operation.
-Rural districts are handicapped in teaching specialized courses.
-Rural districts cannot always offer students a wide range of sports or extra-curricular activities.
-There are fewer opportunities for students to learn manufacturing or industrial types of employment in summer or part-time jobs.
-Rural school boards, like their communities, are often resistant to change.

There are a number of generalizations that can be made about the larger rural infrastructure, based on research of the last decade.[1] For example, employment in manufacturing-related industries is the number one economic growth sector of rural areas. Agriculture is the number two or number three growth area without much promise of expansion, mostly due to international competition. Increasingly, the economy of rural areas is tied to the global economy. We have seen this in global competition for agricultural products. We probably cannot expect federal programs that would lead to a general increase in jobs in rural areas, as it has now been well learned that developing artificial incentives for economy are often quite costly in the long run. We should expect that the development of rural economy is partly a state problem, but it seems mostly up to local initiatives to seek near term solutions.

USES OF INFORMATION TECHNOLOGY

On the surface, information technologies would seem to offer many advantages to rural education. But innovation and success in this area is the exception rather than the rule. Among the barriers to innovation are that small, rural districts may not be aware of new services, may not

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have the in-place technologies to use them, may not have the funds, and may be reluctant to adopt innovations for which they have no direct experience. If there are to be new applications in education, then as much attention will have to be paid to the process of adoption as to the services themselves. Nevertheless, there are examples of successful implementation, as can be seen in the following examples from my state of Texas.

Computing[2]

Texas, as with most other states, has seen a remarkable growth in the uses of computers in the work place, which puts pressure on the schools to teach computer literacy. As of summer 1986, according to the Texas Poll, one in every five Texas households had a computer. One of every three Texans, both men and women in the work force, worked with computers. Currently in Texas schools, computer literacy must be taken for one semester by all seventh or eighth grade students. At the high school level, any student wishing to receive an advanced diploma or one with honors must take one year of computing. That one year may be drawn from the following courses:

Computer Mathematics I or II
Business Data Processing and Introduction to Computer Programming
Vocational Data Processing and Vocation Computer Programming
Business or Vocational Word Processing
Computer Science I or II

Although Texas is well on the way to implementing these requirements, including in rural schools, there is a larger challenge for uses of computers to prepare our children for the information age. As of 1987, according to the Texas Education Agency ("TEA"), there was, at a minimum, a laboratory with 10 computers in each of the 1012 middle or junior high schools and each of the 1305 high schools in the state. This was due to a middle school computer literacy course requirement and a high school requirement for students desiring an advanced high school transcript to take a computing course. It was estimated that there is a minimum of five computers in 75 percent of the state's 3486 elementary schools. In 1988, all elementary schools began to phase in computing applications throughout the basic curriculum.

The State Board of Education Rules of Curriculum also permit the alternative delivery of instruction by technology. To foster the use of instructional technology, the Texas State Board of Education established a number of computer-based instruction demonstration sites. In addition, two legislative bills were passed in 1985 to assist schools in hardware and software acquisition. House Bill 1303 allows the purchase of computers and related equipment from a state bid list, saving money and eliminating the need for districts to go out for bid individually. House Bill 1304 established a software advisory committee to create an approved list of software to be used in Texas schools. The bill provided for statewide software purchasing and licensing agreements and the development of a state long range technology development plan.

The Texas Learning Technology Group, coordinated through the Texas Association of School Boards, is a consortium of school districts interested in the development of instructional technology systems. Their first project has been an interactive videodisc series for science education.

Telecommunications[3]

There are a number of telecommunications systems in use throughout the state for the delivery of instruction and teacher in-service training. The Educational Service Center Region IV "Interact" system provides an alternative delivery system of offering courses for credit. Interact provides four channels of one-way video and two-way audio capability using a microwave transmitter for video and audio, and telephone lines for audio "talk-back."

Education Service Centers have "receive sites" that allow the Commissioner of Education and other staff members to address large number of educators via the network. In the Dallas area, the Regional Instruction Television Consortium supports broadcasting for four channels of video. The microwave signal is received and rebroadcast by many of the local cable television companies, extending the range of the service in the greater Dallas, including rural, areas. A Guidance

Information System provides counselors on-line access to career and college data bases to aid students in vocational decisions.

The TEA currently is implementing a Public Education Information Management System to increase accountability, coordinate information management practices, reduce paperwork, and streamline the process of data collection and analysis. Through this system, the TEA plans to increase its use of telecommunications, by shifting most of its communications with Texas' 1,063 school districts to electronic networks. The majority of these districts are rural and some relatively remote.

In 1987 TEA estimated that this electronic communications system between itself and the Local education agencies would reduce the overall cost of communications and result in a net savings of $2.69 million per year. This projection was based on a pilot study of 15 local education agencies over a 17 month period. TEA spends about $1.2 million per year for communication with local education agencies, two-thirds of which is for reproduction and postage. In contrast, TEA can communicate and store information on "The Electric Pages" for $12,000 a year. Similarly, the local agencies' annual communication costs should be reduced from $3.4 million to $340,000 by using electronic communications just ten minutes a day.

The Electric Pages was started in 1983 by a private firm in Austin with one publishing organization and 19 local education agencies. TEA established a network on The Electric Pages, TEA-NET, in January 1986. By April 1988, 30 TEA agency divisions were publishing information on TEA-NET. TEA sends much of its correspondence electronically to the participating local education agencies, replacing three to four separate mailings a day. Users are charged a $24 annual ID fee and $15 per hour for long distance usage over an 800 number. Local usage costs $12 per hour. Once in The Electric Pages system, local education agencies can access information from networks such as TEA-NET, send and receive private electronic mail, and participate in electronic conferences.

The cost savings noted above are probably sufficient reason to justify a movement to electronic communications. However, its potential for other uses is particularly important. For example, in 1986, six health teachers from around the state developed a publication on The Electric Pages about preventing school-age pregnancy. In the Spring of 1987 a professor from the University of Texas at Tyler taught a course over The Electric Pages using electronic mail and teleconferencing. Homebound students can also use the network for instructional purposes. Thus, the professional isolation of rural teachers, the great distances in Texas, and immobilizing handicaps can be easily overcome by use of electronic communication. TEA is encouraging local education agencies to migrate toward the electronic system by making some information available primarily on TEA-NET.

The Texas, satellite-based, TI-IN Network, operated out of San Antonio and promoted by the TEA, is an example of using a private telecommunications network to deliver educational services. In 1987 about 80 school districts throughout Texas were using the system. Many of these are in small and rural communities, which cannot afford to hire sufficient teachers to meet their needs. Instructional programming, as well as in-service training for teachers, is distributed via satellite to participating schools. The schools use telephone lines to communicate back to the centralized instructors. TEA itself uses the network about two and one-half hours per week to disseminate general information, including a 15-minute weekly news program, to school districts. Instructional programming is produced by the TEA Service Center in San Antonio.

One of the most positive characteristics of TI-IN is that, unlike traditional educational television, the service is personalized for individual classes, is interactive, and is complemented by local supervision and tutoring.

But there remains a problem of adoption. Why would a small rural district not avail itself of TI-IN services? Based upon the author's experiences, several reasons seem prevalent. First, superintendents or their staffs may not know about it or have paid little attention to announcements of availability. Second, unless a teacher is to be replaced with the service, special funds have to be budgeted, and this always a challenge. Finally, "newness" or "change" is itself a continuing barrier in small rural districts. The rural culture tends to value its traditional modes of operation, so something like replacing a customary classroom experience with electronic services may be viewed as too much change. It is also important to consider that importing and paying for outside services may displace a worker in the community economy. Local school boards or administrators may opt to invest money in more teachers rather than technology, particularly if there are teachers in the community who need and can do the job.

As a further caveat, we must remember that many people in rural areas who most need to be reached for basic literacy and skills training are often not in schools or the work places, so there is no particular reason that telecommunications would benefit them.

Teacher Training in Technology

Texas has also adopted legislation, policies, and official guidelines related to technology in teacher education, staff development, and graduation requirements. Current certification requires new teachers to earn three university semester hours of compute literacy. A university based instructional program leads to "computer information system" certification. A system of "Advanced Academic Training" is provided for all curriculum areas and delivery systems. Technology training can take place with the framework, which is linked to a statewide "career ladder" program offering merit pay.

EDUCATION FOR EMPLOYMENT

Many of us in rural education argue that if there is one investment a rural community can make in its future, it is education of the work force. Increasingly, if industries and related businesses are to locate in rural areas, they will need not only reasonably educated work force, but one that is comfortable with new technologies of production. Among these new technologies are the many ways that computers and telecommunications are used in modern manufacturing and the delivery of services. All of this places a particular challenge upon rural school districts not only to maintain a quality of basic education, but to allow rural students to have sufficient training in order to compete for jobs in an increasingly technological society. This makes education a critical investment for rural America. It appears as if the challenge to rural education is one of ***education by, for, and about technology***.

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[1] U.S. Department of Agriculture. Rural Economic Development in the 1980's: A Summary. Agricultural Information Bulletin Number 533, Oct. 1987.

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BEYOND 2000: TECHNOLOGY ACROSS THE CURRICULUM

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ABSTRACT

Current teaching strategies and curricula are inadequate to educate students who will need to use and understand "volatile" technologies and "smart" machines throughout their professional careers. Using the opportunity of opening a new secondary school, a team is creating an approach to technological studies which will emphasize project driven courses, team teaching, the elements of design leading to production, work experience, and community involvement.

BACKGROUND

Within a state-of-the-art secondary school opening in 1990, a team is developing a curriculum delivery model to serve students who live in an area sometimes called "Silicon Valley North" because of its proximity to the University of Waterloo. Local industry is diversified and expanding because of the free trade agreement and Japanese and European investment.

Technology across the curriculum will be the major focus at Resurrection Catholic Secondary School to attempt to address three inter-related problems: an adequate student awareness of new technologies and options within traditional trades, a lack of effective teaching strategies in technical education and a high student drop-out rate. Traditionally, technology has been reserved for academically weak students and computer studies has been the domain of the bright. Teaching strategies have been "curriculum-driven" in a very repetitive theory-lab-theory fashion. Connections between various technologies were seldom indicated and liaisons with industry were rarely established. Technology has been perceived as blue collar drudgery with few opportunities for career success. As a result, 70% of high school students plan to attend university or college while only 4.3% plan to enter skilled trades. The staggering reality is that 65% of students do not enter post-secondary education; many end up in unskilled and less satisfying jobs.

Students in our region have an opportunity to study academic programs at three levels of difficulty: advanced, general and basic. University-bound advanced level students are considered the elite of the school; programs in technology have been limited for this group and in some cases discouraged, supporting the myth that technology is reserved for the blue-collar class. General-level programs have been diluted advanced-level curriculum with no specific practical focus or teaching strategies. As such, the self-image of these students suffers and the general perception of skilled trades or technology as undesirable is confirmed. Basic level courses are delivered for academically weaker students heading directly to work entry. Rather than specific programs

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which address the world of work and promote the development of personal and interpersonal skills, this group has received an even further diluted academic curriculum. This results in confusion, frustration, impractical learning and high drop-out rates.

PROPOSED DELIVERY MODEL

An innovative curriculum delivery model is proposed. Technology courses will incorporate the following five components. First, technology courses will be project-driven, not content-driven. A project such as the building of a computer, restoration of a car or technical support for a major play becomes the focus around which curriculum, theory, practice and skills take their patterns. This approach makes the student the proprietor of the learning process with clear benefits and relationships among its components. Second, all courses will follow a design leading to production method format which promotes problem-solving skills and activity-based learning. Third, all technology programs will be more closely integrated with one another philosophically and physically so that students see connections among various technologies. For example, a course in transportation may involve engine repair but also electronics, plastics, drafting and computer technology. Fourth, students come to see that technologies are mutually related to, and respected by, the other academic disciplines through the formation of multidisciplinary teaching teams. Fifth, all technology programs will be linked to the community through work experience programs and co-operative education placements.

In addition, the three streams will be renamed to the following: Transition to Employment; Readiness for Apprenticeship and Technical College; and Design Technologies.

For example, students taking the Readiness for Apprenticeship stream will take a double credit in each of Grade 9 and 10 where they rotate through each of Transportation, Construction, Manufacturing and Communication. Technology courses will be teamed with Mathematics, English and Arts courses. By re-arranging the timetable and identifying team members, greater communication and mutual planning is achieved. A typical English class may undertake a module in technical report writing or communication skills in the workplace, a natural outcome since the English teacher has been an integral part of the technology team.

Senior level students are given more technology courses from which to choose. Again, technology is teamed with other disciplines such Entrepreneurial Studies and Science.

COMMUNITY EDUCATION

Students registered in the technological studies course will have their academic experiences enhanced by intervention strategies and opportunities for experiential learning at every stage.

Students involved in Transition to Employment and those who are in Readiness for Apprenticeships and Technical Colleges will gain practical experience and motivation in the first two years of high school through a gradual integration with a local industry. The first semester consists of job shadowing, a relatively simple process in which the student is assigned to observe, and perhaps even help, a skilled tradesperson for an afternoon a week for the last five weeks of the semester. Interest in the particular skilled trade and industry is determined in active career counselling sessions at the beginning of each semester and assessed by employers, teachers and students at the end of the semester. This process is repeated during the second semester at the same industry if very successful or at a different one if less so. During the second year, students will be at industries for a maximum amount of time allowed by the Ministry of Education, ten days per semester. This constitutes twenty afternoons, approximately two per week. The third year has a full two-credit co-operative education experience in the student's chosen field with emphasis on practical steps for career preparation such as resume writing, letter of application and successful interviewing skills.

Students who are in Transition to Employment will spend the last semester of the fourth year directly in the industry of choice and will ideally enter this industry as a full-time employee upon graduation.

Students who are preparing for apprenticeships or technology at a community college may spend a full semester at the industry or college. In industries with high needs for skilled tradespeople and apprentices, there are satellite classrooms presently in operation with students from across the board. Where there are four or more students at the industry, it is practical for the school system to send teachers to it to teach Business English and technical mathematics on site using assignments from the day-to-day business of that industry. Company personnel lacking high school certificates are encouraged by some industries to join these classes and graduate with the students.

University-bound technological studies students have job shadowing experience during those semesters in which a computer or technical subject is taught. They would not be mandated to five afternoons but would be of varying length, not for integration of the student into the work environment but as a forum for illustrating the practical value of mathematics and science and the integration of computer with all industrial technologies and professions. One of the most exciting co-operative education experiences for these students is a satellite classroom initiated by our board on campus at the University of Waterloo. Students take two co-op credits in the subject of choice by acting as a research assistant for a professor. Students are encouraged to take a university credit for which they have the prerequisites. They then return to their home schools to finish their fifth year and graduate.

Students who have been integrated into their post-secondary career choice throughout their high school careers are much more motivated and higher achievers than those who are not. Their success after high school seems to be greater, particularly those who have had experience with a university environment and know that professors are there to assist them.

All of the teachers who set up and implement work experiences for their students must learn about their industrial community, its assets and employment needs. This provides a natural internship for many teachers who have not been actively involved in this world for many years. Teachers who are actively involved in the satellite environments find their teaching enhanced and much more individualized to the students' needs. University and community college personnel who become involved with the students act as resources for classes on site and back at the home high school. Because of the system-wide approach to such work experience, the community is actively involved with and interested in our students. The practical and topical nature of so much of the students' education is helpful in addressing parental anxiety about the technological literacy and employability of their children. The whole community now seems to understand the nature of partnerships in secondary education.

COMPUTER-BASED TECHNOLOGY IN AN INNOVATIVE MIDDLE SCHOOL FINE ARTS CURRICULUM

Susan K. Zellers*and Dr. Eric A. Witherspoon**

ABSTRACT

The integration of microcomputer technology into the existing middle school curriculum draws upon the creative capabilities of the computer and its related technology. Micro-based graphic arts learning experiences have been blended into the fine arts curriculum, enabling all art students to express themselves visually and creatively within the framework of a new, technology-based language.

Using the Apple IIGS, with its superb graphics capabilities, various digitizers and video reproduction devices, students learn to visualize the light, texture and dimension that comprise the images they will interpret and create. The computer serves as a tool which enhances students' fine motor skills, allowing students to express their creativity using a new medium or on a new plane.

The micro allows of an in-depth, unique unlocking of each student's creativity, breathing new life into a traditional segment of the middle school curriculum.

INTRODUCTION

At Hobart (Indiana) Middle School, students in grades six through eight participate in a sequence of semester-long courses designed to introduce them to computer-based graphics. Traditional topics (i.e., line, tone, form shape, balance, color and texture) are made exciting and alive through the use of the computer as the primary design tool. The need to express oneself visually becomes increasingly more important to the middle school student. These students can greatly benefit from the non-threatening, non-judgmental learning environment that computer-based technology provides.

PROJECT DESIGN

With a variety of techniques, both traditional and hardware based, the art curriculum has been expanded to provide a multitude of materials and experiences for the student. Lessons have been developed beginning with traditional line and tone instruction, which is then expanded to utilize the best that computer-generated graphics can offer. Students, by the end of the sequence, explore the possibilities using the Apple IIGS

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computer, AST digitizers, graphics tablets, the mouse, video equipment and sophisticated software that allows for color output. Initially, students create in BASIC on Apple IIe's with monochrome monitors, in tones of grey, without the benefit of any peripherals. Gradually as they progress in terms of design sophistication, students are introduced to input peripherals, complex software and the unlimited possibilities of the computer when coupled with their imagination.

Software products used include The Complete Graphics System, Dazzle Draw, SuperPaint, Fantavision, Graphics Studio and Paintworks Gold, many of which take advantage of the Apple IIGS's uniques graphics capabilities.

SUMMARY

This infusion of the computer into the arts has involved many students who normally would have struggled through the coursework with little enthusiasm. It has enabled those students who did not consider themselves "artistic" to use other media that they could manipulate creatively. Students participating in this project have also realized that art is not only drawing, painting, sculpture, etc., but it is the process of creation, of making concrete an idea, a thought, an attitude and expressing it using a medium that they can effectively manipulate.

Future plans for expansion include the increased use of animation, the creation of living stories and cartoons. The design of art for Desk Top Publishing in the middle school journalism class, expand into desktop presentations. Students would like to be able to truly integrate art into other facets of the traditional curriculum, and using the computer and the design techniques that they have mastered to enhance presentations and reports, publish research findings, improve the "look" of in-school publications.

In the public schools we continue to discover new and exciting ways to use computer-based technology as a tool for enhancing students' learning experiences.

TECHNOLOGY AS A DISCRETE COURSE IN THE SENIOR HIGH SCHOOL

A. D. MacPherson *

ABSTRACT

Technology is developing so rapidly that it is impossible to predict exactly what technological skills will be needed in the future. The New Brunswick (Canada) Department of Education decided that this province's students must develop skills that are useful despite future changes. They must be taught the skills to understand new technologies as they evolve. The decision was taken to develop a discrete course, called Technology 100, which would help students become better able to adapt to the ever changing world around them.

BACKGROUND

The Department of Education formed a Task Force consisting of teachers, departmental personnel, and personnel from the University of New Brunswick to develop the course. The mandate given the Task Force to develop this specialized course stated that it must: provide an understanding of technology; provide for a "hands-on" experience; have a focus on production; provide a problem-solving experience; have a practical life-skill value; and have a basis in an occupational area.

The Task Force found that the term technology is used in several contexts and had to adapt their own definition: *Technology is the process of using tools, techniques, resources, and knowledge to extend an individual's or society's capacity to meet predetermined goals.*

INTRODUCTION

The Task Force adopted as its position: "Technological change and global competition make it imperative to equip students in public schools with skills that go beyond the 'basics'. Productive participation in a society that depends more heavily on technology, dictates that students will need more than minimum competence in reading, writing, mathematics, science, reasoning, the and the use of computers. They must have a background in communication, higher problem-solving skills, and scientific and technological literacy--*the thinking tools that allow us to understand the technological world around us.*"

The Task Force agreed that in the future the effect of technology in changing the patterns of our daily lives will become ever more significant and at an increasingly rapid rate. They believed that all students need to have an understanding of how the process of technology works so they can perceive what it can and cannot do for them. They also acknowledged that today's student needs a quite significantly different set of knowledge, skills and aptitudes to that provided by the traditional school curriculum.

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RATIONALE

Technology is likely to alter the relationships between one individual and another and between individuals and their work. New Brunswick students will need to be aware that the speed of change is accelerating and that their future careers may well include many retraining stages as they adjust to new technological developments. The Task Force attempted to build this philosophy into the Technology 100 course.

Several educational reformers have expressed concern over the inordinate emphasis schools give to factual knowledge at the expense of "procedural knowledge and skills." One means of obtaining this *procedural knowledge and skill* is for students to participate in a hands-on experience in as close a real world setting as can be provided--this is called "action-based learning." Technology 100 uses this premise in its form of delivery which is based on an understanding of theoretical concepts and emphasizes creative thinking, critical thinking, decision making, problem solving, and objective analysis while performing a series of appropriate "student ventures."

THE COURSE

The current research findings and practices in technology education were carefully studied during the development of Technology 100. The basis of the curriculum philosophy came from the Jackson Mills Curriculum Theory, a theory that has gained wide acceptance throughout North America. The Open University Technology Curriculum which has gained acceptance in Great Britain was also used in the design. Other curricula were also reviewed and considered during the development stages. The philosophy embraces four major concepts: (1) tools, resources and processes, (2) the cycle of change, (3) problem solving, and (4) systems and subsystems.

The focus of Technology 100 is on the development of the student by exposure to relevant technological experiences. The course provides a study of the evolution, significance, and utilization of technology in the world. After students have been provided with the appropriate background, situations are created where they will experience the application of technological processes in business, industry and personal living. Each student will develop an understanding of technology and his or her individual potential within a technological environment. To do this, the course uses an application of technology as a key feature. This provides each student with first-hand experiences in seeking solutions to real technical challenges. The emphasis is on the problem solving process more so than the solutions to specific problems.

During the 1987/88 pilot year, this full-credit (120 hour) course was delivered as a series of modules which enabled students to meet their individual needs and schools to effectively use their resources. There is a compulsory Foundation Module of 40 to 60 hours which will provide basic knowledge on the nature and uses of technology. Two or three additional 30 to 40 hour modules designed to enhance the Foundation Module are required to complete the course.

The overall structure consists of the following modules: Foundations Module; Business Systems and Solutions Module; High-Tech Living Module and; Exploring Electronics Technology Module.

Each module has its own specific objectives, but all provide each student with an opportunity to both gain a perspective of how systems of technology function, and provide an opportunity to experience technological activity using complex technological systems and tools.

All modules use the *Universal Systems Model* of Input, Process and Output. The inputs to the system provide all needed resources to accomplish the goals of the system. The processes are the appropriate means of bringing about system goals using the inputs (resources). The outputs of the system include the ends or goals (products, services, or desired results).

The Foundation Module and the supporting modules divide technology into three broad categories: (1) The Physical Technologies, (2) The Information/Communication Technologies and, (3) The Biotechnologies. In this course the physical technologies are: construction, energy and power, manufacturing, and transportation; the information/communication technologies are computer technology, graphic communication, and electronic communication; the biotechnologies are agriculture, health care/medical technology, and the extending of human ability.

The microcomputer plays an important part in this course along with appropriate tool-type software, such as word processing, spreadsheets, data bases, desktop publishing, communications, and CAD. The computer was supplemented by a simple robot arm, a microwave/convection oven, electronic kits and hand-tools, along with supplementary resource materials, including a variety of video tapes, for teachers and students. All resources were supplied by the Department of Education for the pilot project.

INSERVICE

Upon selection of the 14 pilot schools appropriate school administrators and pilot teachers were provided with basic information about the course during a two-day meeting held at a central location during the spring of 1987. The pilot teachers were provided with additional detail, documentation, textual material, and copies of the computer software to be used during the course.

During the summer of 1987 all pilot teachers were provided with the opportunity to participate in a two-week intensive institute on the various modules. All pilot schools were represented during some part of the institute.

In the fall of 1987 and the winter of 1988 a series of workshops was held to follow-up the summer institutes which reinforced the knowledge and skill required to teach the various topics covered in the modules.

Pilot teachers were kept informed of pilot activities through a series of memos from the Department of Education. The project was allocated space on the Department's electronic communication network for use by the teachers for sending and receiving messages and information, and also for the students to experience this form of technology.

EVALUATION

The pilot teachers were periodically brought together for a debriefing session where comments on the course were received and ideas exchanged.

A formal formative evaluation was held during the Spring of 1988. Teachers and students completed a questionnaire which requested their opinions on a variety of related topics. A team of four educators made on-site visits to seven of the pilot schools during which appropriate interviews were held and observations made.

The opinion surveys, classroom observations, teacher interviews, and discussion with students clearly indicated that Technology 100 was meeting its stated objectives.

CONCLUSION

Technology 100 is designed to provide a stimulating and interesting challenge to our students. It is not a vocational course, nor an academic course. It is neither solely activity based, nor solely based on theory (It requires both academic and practical skills). It is organized in a fashion that reflects the philosophy of technology. It will require students to use the tools, attitudes, and generic skills of technology. The activities will require students to plan, to make decisions, to consider alternatives, to research, to work in groups, to experiment, to construct, to test, and to report findings. In short it creates situations where students can sample technological problems and attempt to solve them using technology.

The comment of one of the pilot teachers on the opinion questionnaire clearly sums up the success of the course with the statement: "I believe this was one of the best courses added to the high school program in years. Our experiences this year have only seemed to confirm that belief."

THE ONE COMPUTER CLASSROOM

K. A. Maury Berwanger

ABSTRACT

The one computer classroom can be a very stimulating place to teach and learn. One computer can become a teacher tool, a teaching tool, or a student resource. As a teacher tool, the computer can keep classroom records, compute grades, or print letters to students or parents. As a teaching tool, one computer can be used to supplement teaching in almost any content area or grade level. Probeware can be used during large group teaching to demonstrate science concepts or one computer image can be projected for large group cooperative study of a social studies simulation. Also, one computer can be used effectively to demonstrate mathematical relationships as part of a math lesson. While teaching effective writing skills to large groups of students, one computer can be used for group editing of phrases, sentences or paragraphs. Finally, one computer can also be used as a student resource. Data banks of study questions and database stored information can become a social studies tool for use by individual students. The computer can also be used by students to test mathematical conjectures or as an actual mathematical tool to perform mathematical algorithms. Also, individual students can use the classroom computer to test the spelling of a specific word or to write simple paragraphs as part of content area assignments. Yes, one computer can play an active role in the classroom. It can serve as a teacher tool, it can project images for use during large group lessons, and it can serve as a student resource.

THE COMPUTER AS TEACHER TOOL

By far the most common use of one computer in a classroom is that of a tool to help with the evaluation and reporting of student progress. One computer can be used to store, process, and report student progress to parents, students, and others. Typically teachers select a simple to use, low-powered integrated package. These low-end systems seem to function quite well to serve the data storage needs of teachers responsible for about 25 to 150 students per day. All types of classroom records are often stored using these simple integrated software systems. The data base or spreadsheet can be used to store information about student's daily assignments. Later, these data can be used to electronically calculate and report grades. Information about student's daily assignments and grades can then be included in letters written to parents, students, and others using a (simple to use, low-powered) mail-merge software system.

Used for the purpose of storing, processing, and reporting of student progress, the computer becomes a teacher productivity tool, and often increases the communication range of the classroom teacher. The teacher can communicate more information to more people, with greater accuracy, more often. The student, the parent, and the teacher become better informed about student progress. In order for a teacher to effectively use a computer to improve information exchange, the computer must be easily accessible. That is, the computer needs to be available to the teacher on a consistent basis. It needs to be available for use at whatever location the teacher works. For most, this is the classroom.

THE COMPUTER AS A TEACHING TOOL

One computer in a classroom can be used very effectively as a teaching tool to help deliver instruction in the content areas. When used for this purpose, the computer needs to be interfaced to a large screen monitor, a large screen television, or a projection device. Software specifically selected for this purpose should easily integrate into the school curriculum, and the teacher needs the time and opportunity to practice teaching with the system. For the most part, the computer system is used as a more powerful, fully functioned overhead projector. It offers the opportunity to demonstrate concepts and ideas that cannot be demonstrated with any other tool. Concepts that involve knowledge presented as integrated and dynamic, motion, or the integrated nature of knowledge can easily be demonstrated using a computer system and software specifically selected for this purpose.

In mathematics, a projected image may be used to help develop geometric notions of rotation or congruence. Teachers working with students might develop theorems or test group generated hypotheses. Elementary mathematics teachers might demonstrate the notions of data summary and representation for their elementary class. Upper level mathematics teachers might demonstrate concepts from calculus, test theorems or conjectures using graphing utilities, or simply use the computer as a number cruncher. This use of the computer as a number cruncher in mathematics education frees the teacher and the students to concenrate on the mathematical concepts, eliminates the need to do pencil and paper number crunching, and provides mathematics educators with new direction and purpose.

Probeware (software that uses various types of probes as input devices) can be used in large group teaching to demonstrate science concepts. The computer becomes a data gathering, synthesizing, and reporting tool. The science lesson becomes a lesson in which the students make group decisions about what data to gather, determine the questions to ask of their data, and often formulate a group interpretation of the computer output. The computer collects and processes the data. The teacher and students become decision makers and interpreters. One computer used as a large group teaching tool in the science classroom often directly effects how science is defined.

Within the world of social studies education, one computer is often used to run simulations, generate group questions, delve into local and global social questions, querry data base information for specific data, or generate visual representations for social data. One computer can help students view social situations as complex arrangements of interrelated information, and offers the advantage of group interpretation of simulated information. One computer in the social studies classroom offers an opportunity for students to learn about the interrelated nature of the fields of social studies, and an opportunity to interactively becolme involved in social studies simulations.

One computer can also be used effectively as an aid while teaching writing skills. A word processor interfaced to a large screen projection device can be used to demonstrate sentence and paragraph construction techniques, outlining skills, or editing techniques. Writing concepts that involve addressing a specific audience and audience interpretation can be easily demonstrated and tested within large group writing lessons. One computer can often be used to demonstrate writing concepts that involve communication techniques.

THE COMPUTER AS A STUDENT RESOURCE

Perhaps the most common use for one computer in a classroom is as a student resource. Students often use one computer as a spelling aid during writing time. Simple to use spell checkers are available that can be used effectively to check individual words. Used in this fashion, the computer becomes an electronic dictionary that students can use quickly and effectively. Also, one computer can be used to complete short writing tasks for content area assignments. In addition, one computer can be used for general information retrieval. Data base searching techniques can be taught and then used by students to gather information to complete content area assignments. The computer becomes another resource among many available to students.

As a mathematical resource within the mathematics classroom, one computer can be used by individual students to test theoretical mathematical conjectures that can then be referred to in mathematics assignments. Often, the computer is used to perform mathematical algorithms while the output is used within the math assignment. This amounts to using the computer as a number cruncher. This use of the computer frees the student to concentrate on mathematical concepts, and provides algorithmic output as input to concept building within the student. This is perhaps one of the most valuable uses for one computer within the mathematics classroom.

SUMMARY

One computer can function quite nicely in a classroom. It can serve the data storage and processing needs of the teacher, it can become a teaching tool, or it can become a student resource. One computer can be made available (with the proper software) to individual students as a resource to use as they seek information to complete assignments. Very often, one computer can be used effectively to improve instruction.

ONE COMPUTER IN A CLASSROOM

I. Varma*

ABSTRACT

One computer in a classroom can revolutionize the normal teaching. Exciting things can happen with one interactive machine at one's beck and call. A single computer attached to a large monitor and a few pieces of good software can enhance the instruction in many ways. However, the mere availability of a computer and software is no guarantee that learning will take place, for it is teachers who teach and not the software alone. Hence, careful planning is needed.

INTRODUCTION

'Electronic learning is the new technology of education'.[1] We are heading into 'a computer rich future, a future where a computer will be a significant part of every child's life'.[2] The growing proliferation of computers makes one realize that 'as the Information Age expands, any well-rounded program should comprise computer applications and an understanding of the computer as a tool for expanding the mind'.[3]

Frequently cost is an important factor which prevents many educators from using computers in their program. School districts find it difficult to set up a computer lab for every school. However, obtaining a single computer, a large monitor, and some good software may be a realistic option.

The question teachers often ask is of what use will one computer be to me when I have thirty students in my class?

The truth is that the curricular applications of using a single computer in a classroom are wide and varied by which a teacher can 'foster the idea among students that the computer is a tool'[4] of the Information Age.

APPLICATIONS OF A SINGLE COMPUTER

A single computer at one's disposal is an invaluable aid in all aspects of teaching. 'Appropriate software can help the teacher create a manageable environment to focus on thinking'.[5] Three types of software suitable for use with a single computer consists of - programming languages such as Logo, applications software of word processing or data base type, and ready made programs for Computer Assisted Instruction.

The software usage plan in table 1 lists the programs that I have used in Math, Language Arts, and Social Studies classes.

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Table 1 SOFTWARE USE PLAN FOR A SINGLE COMPUTER

SUBJECT & PROGRAM	LEARNING AREA	SKILLS TAUGHT
Language Arts		
Missing Links (Sunburst)	Reading comprehension	Making inferences, establishing links
First Choice word processing (Software Publishing Corp.)	Writing, spelling, vocabulary	Listing, Classifying (nouns, verbs, etc.) analyzing
Wizard of Words (Advanced Ideas)	Vocabulary, spelling	Word construction, unscrambling words
Writer Rabbit (Learning Co.)	Grammar, writing	Parts of speech, writing
Math		
King's Rule (Sunburst)	Problem solving	Inductive reasoning, hypothesis testing
Safari Search (Sunburst)	Problem Solving	Deductive reasoning, hypothesis testing
Logowriter (LCSI)	Geometry	Programming, spatial relationships
Social Studies		
Where in the World is Carmen Sandiego? (Broderbund)	Map reading, researching, reading comprehension	Research skills, decision making, establishing links
First Choice data base	Researching, writing reports	Research skills, questioning, analyzing

A large monitor attached to a single computer is a useful tool for teaching various facets of a Language Arts program. The utility of a word processing program equipped with a spelling checker and a thesaurus goes beyond its basic typing application. While showing the use of a spelling checker the teacher can review spelling rules, or build vocabulary by discussing subtle differences in meanings of the numerous word options available in the thesaurus. A style analyzer such as 'Right Writer' assists not only in reinforcing grammatical concepts but also encourages the students to improve their writing if the program rated their writing below grade level.

Examples of students' writing projected and analyzed on the large screen make writing a meaningful exercise. Games like 'Wizard of Words' can make learning vocabulary and spelling a thrilling experience as two groups intensely compete against each other.

Amongst the many aspects of a Math curriculum perhaps the hardest to teach is problem solving. A class using one computer and working on a program such as 'Safari Search' or 'King's Rule' can be divided in two teams playing against each other. Learning and fun co-exist as the group members use deductive and inductive reasoning to plan and modify their problem solving strategies.

Logo is a marvellous discovery learning tool. The students are forced to think and get physically involved in programming the turtle. One child acts as the turtle while others give it directions which the teacher types simultaneously on the computer. 'In teaching the computer how to think, children embark on an exploration about how they themselves think.'[6] Logo procedures demonstrated on a large screen allow the teacher to not only explain how to do the assignment, but also respond to 'what if..' type of queries of many students.

An excellent way of using one computer constructively is in Social Studies with the use of a data base. It 'provides an ideal environment for students to learn to organize, analyze, synthesize, and evaluate information.'[7] 'Opportunities for student inquiry, problem solving, and skill development with data bases are endless.'[8] The real advantage lies in its ability to develop critical thinking skills. 'We want students to think for themselves and not merely to learn what other people have thought.'[9] The fact sheets my students completed on countries gave a new perspective to their research when the information contained on these was entered in to the world countries' data base. The whole class then became involved in assimilating information and drawing conclusions based upon their queries of the data base. They searched through the material and got beyond the factual details to establish relationships between various pieces of data.

Games like 'Where in the World is Carmen Sandiego?' can be played by the whole class impersonating a sleuth hot on the trail of Carmen. Looking through the Almanac, locating places on the world map, studying the clues, and determining the strategies for the next move can make this game a stimulating group activity.

CLASSROOM SET-UP

With proper planning a single computer can be used advantageously by individuals, small groups, or even an entire class.

Individual Use: Remediation, extra practice, or enrichment can be easily provided with individual use of the computer.

Some bright students are invariably finished with their regular class work early and can use enrichment activities such as entering information in a data base, or working on a school newspaper. Others need scheduled time to practice additional skills.

A word of caution is necessary here. Clear and simple instructions posted by the computer, a designated helper, a suitable location where the computer is not a distracter, and a posted schedule of users can assist in avoiding problems.

Small Group Use: The class can be divided into two or more groups for the purposes of playing a game or doing a specific task, such as picking out parts of a sentence in a program like 'Writer Rabbit'.[10]

Entire Class Use: Many activities are suitable for entire class use. For example, students' ideas can be typed on a word processor in a prewriting exercise which ranges from 'brainstorming or clustering ideas to researching and participating in sensory experiences'.[11] A hard copy can be made available later to serve as a story starter for writing the first draft. Similarly, analysis of a written composition for editing or elaboration done on a large monitor provides 'not only an instructor's comments, but also a range of peer review responses'.[12]

Thus, it is clear that even a single computer is effective in providing many benefits ranging from extra practice to the development of thinking and problem solving skills which carry over into adult life.

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THE USE OF A SINGLE STAND ALONE COMPUTER IN A CLASSROOM

GWYNETH WINDSOR*

ABSTRACT

The stand-alone computer has helped to develop both life and subject specific skills. Groupwork based lessons have encouraged active learning methods in which the computer has played a major role. I have found that the creative use of applications software has given pupils greater self-confidence and improves motivation. Attainment levels have improved, particularly with the lower ability children. Student research has been assisted by the use of resource files. Digitised and scanned graphics have also improved the quality of pupil output. The stand-alone computer has revolutionised my lessons, and I believe that the children's standard of education has improved.

FULSTON MANOR SCHOOL

Fulston Manor School is a Secondary School (that means we have pupils aged 11-17) in South East England. There are 750 pupils, both boys and girls. At 11, children transfer to us, and for the first two years, we have pupils of all abilities who are taught in ability groups of about 32 . At 13, the children with the greatest academic ability transfer to one of the two single sex Upper Schools in the area, and the remainder continue their education at Fulston Manor.

English Schools are required by Law to teach Religious Education (RE). According to the 1988 Education Act, it must be "broadly Christian, though taking account of other cultures". My job is to implement this in as interesting and creative way as possible. Each class will have two 35 minute periods of RE per week.

I have been using a computer within RE for a little over a year. Its introduction has meant a great change in my teaching style. A total organisational re-think was required so that the computer could be used effectively. It would have been all too easy to use it simply when someone had finished their "real" work, and to treat it as a toy, or time filler.

The temptation to do this was probably avoided because of my own introduction to computers. I had been completely computerphobic. Despite the assurances of my teenage family that the thing was useful, all they ever seemed to do was to shoot things down or blow things up! When, however, I was shown what a Word Processor could do, I began to see countless uses within my classroom.

The first problem was simply one of furniture. Classrooms are set up to accommodate thirty two. My immediate solution was to abandon having a teacher's desk, and use that for the computer. This changed my teaching style. I became more involved with the children and there was greater spontaneity. The computer was installed near one of the room's two

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electric points. My task now was to learn to use it as an effective teaching tool.

LEARNING TOOL

A computer is one of the tools which a teacher can use to help the children develop both skills for adult life and the subject specific skills of an individual discipline. By regarding the computer as a tool, I began to think about the way practical subjects organise their work.

In technologically based subjects, the teacher would not expect to have everyone using a lathe, or a bandsaw at the same time. He would expect to organise his class so that the most efficient use could be made of the tools at his disposal. Neither would he expect every lesson to involve the use of all of these tools. Some lessons will always need to be theoretical, and these will frequently need to be taught as a class lesson.

It seemed possible, therefore, to begin to adapt this pattern for my situation, and to begin to see the RE room as a sort of Workshop for learning more about RE. The Computer was a major tool in this workshop. Others included Bibles, reference books, painting and drawing equipment, scissors, glue, religious artefacts, videos, audio tapes and recording equipment, as well as the use of the school video camera, etc. In this change of style and emphasis, the computer played a large part. It helped me to change RE at Fulston Manor School from a knowledge based subject to a skills based subject.

Most of my lessons are now organised into groupwork. One of these groups will usually be based around the computer. Other groups may sometimes need to use the computer for various other activities, and thanks to winning the Tandy DeskTop Publishing Competition, we now have two computers in the RE room. I usually plan to have a set of lessons on a particular theme. The first of these is often a class lesson during which the new theme is introduced. During the other lessons on that theme, pupils are divided into groups with their own assignments. The final lesson of each set tries to draw together what each group has learned, and to give value and recognition to the achievements of each group.

FIRST STEPS

The RE Department's first computer was the CP/M based Amstrad PCW 8256. It is a very versatile machine which can do almost anything that it's big brothers can do. Despite the fact that it has only 256k of RAM, there are excellent DeskTop Publishing packages available for it, as well as some good database and spreadsheet packages, versatile graphics, and the ultimate in user friendly wordprocessors, Locoscript. It was with Applications software, rather than any subject specific software, that the children and I began to experiment together to make the best use of our new computer.

From the first, it was a joint venture. We set to discover what the computer would do, and how we could use it. Together we worked out how to get some of the programs running, and as often as not, it was one of the children who would excitedly discover some new feature. Certain children quickly became experts with certain programs, and would find great joy in passing on their new found knowledge.

Although at first, I needed to show pupils how to load programs and to get started, soon there were children in each class that I could call upon to pass on to others the basic information. I could then spend time with groups other than the one working on the computer.

SOME EXAMPLE ASSIGNMENTS

Sometimes, pupils work on the same task, but approaching it through the use of different tools. For example, if the topic on which they are working is to produce an edition of the "Jerusalem Times" for the week after the Resurrection of Jesus, then some groups will be producing their newspaper manually, using cut and paste methods, whilst other groups will be using a Desk Top publishing System. Some groups may end up by using a mixture of each system, prefering to draw their own pictures, and using DTP for headlines and text. On the PCW pupils seem to prefer NEWSDESK INTERNATIONAL from Electric Studios, although we do have Stop Press and the Desk Top Publisher as well. On the Tandy 4000, they like Mirrorsoft's Fleet Street Editor, with its terrific graphics files.

On other occasions, pupils may well be working on the same theme, but engaged upon different tasks. For example, working on the topic of the Resurrection of Christ, the groups might work as follows:

Group 1. Produce an edition of the "Jerusalem Times" for the week after the resurrection. Write your stories on the Wordprocessor, convert them to ASCII files, and download into DTP. Your Graphics may be drawn and pasted in; created on Newsdesk or Masterpaint and introduced into the text; scanned in from your own or other drawings or pictures; or digitised and downloaded from a video.

Group 2. Using a Bible Names Database or Bible Dictionary, find out as much as possible about the people who saw Jesus alive after the Resurrection. Use this information to produce interviews with each of these people, and record these on Audio Tape.

Group 3. Your group has been commissioned to make a new documentary about the facts surrounding the death and resurrection of Jesus. Use the Four Gospels to research your facts, and then, using the school video camera, produce your own documentary.

Group 4. "WRITERS AND ARTISTS WANTED" to produce a book for 5-7 year olds called "Jesus is Alive". You will need to research your facts using the Four Gospels, and then write text and draw pictures which are appropriate to that age-group.

Ref: J H Hughes & G M Windsor, Exploring Christianity (Heinemann, 1988)

APPLICATIONS SOFTWARE

The above assignments show that we make no use of simulations and educational software. At first, this was because there wasn't any.

Later, I came to realise that the absence of this had made me much more creative in the use of the computer. I had to adapt software which was easily available. I believe that it is vital to introduce young people to the same kind of software as they will meet at work. They will be familiar with similar programs, and realise that a computer is there to do a job of work. It is a tool, a functional piece of equipment, not simply an optional extra which makes learning more fun.

It has been exciting to observe the way in which the use of the computer has given extra confidence to some pupils. Certain pupils seem to perform better when they are faced with a keyboard and screen than with a pen and paper. This applies specifically to pupils of lower ability whose written work improves enormously when produced on a word processor. Suddenly, the content becomes more creative and interesting, and they start to use words which they would not usually use. A spelling checker eliminates the problem of poor spelling, and apart from typographical mistakes, spelling seems less of a difficulty on screen. I wonder whether this is because the letters which appear on screen are easier to relate to those which they have met in books.

Locoscript has a superb disc management system which has been easy to adapt for students researching their own information. They are able to select the correct disc containing their information, and then the document they wish to examine. They can read the document on screen, or print it out for later use. Students discovering something new which they would like to add to a research disc, can do so very easily. Their findings can then be useful to others. Worksheets are also kept on these discs, and a student may also select their own appropriate assignment.

I have tried to build up libraries of graphics which all pupils can use. These may be clip art files, or images which we have digitised from video and saved, or scanned in images from other sources. Sometimes they are graphics created by pupils themselves. Obviously the purchase of a video digitiser and (cheap) optical scanner had immediate benefits in the quality of work which pupils were able to produce.

OUR NEW TANDY

One of the most exciting developments has been winning the first prize in Tandy's DTP competition. The advent of our Tandy 4000E and laser printer has enlarged our horizons greatly. We have benefited by having two computers in the classroom, and I have moved into the Library. There, the two machines have become a resource for the whole school. We have been able to build upon the experience gained with the PCW as we have come to terms with the greater potential of a Hard Disk Machine.

I believe we have made a good start on learning to use a stand alone computer in an ordinary classroom situation. I hope we will go on learning and developing better techniques to make the most efficient use of Information Technology.

PREPARING STAFF DEVELOPMENT MODULES for STATE-OF-THE-ART COMPUTER EDUCATION

Françoise M. Miller*, Nancy A.S. Miller*

ABSTRACT

The central theme in the Indiana Department of Education's commitment to educational technology in its 1900 schools has, for the last four years, addressed the existing needs as well as the demands made on educators by the technological advances to be found in the schools of tomorrow. The design and implementation of open-ended, custom-prepared modules, which are part of an extensive on-going teacher training program, show that given a short period of time, such an approach has great potential in preparing teachers to become dynamic leaders of change.

BACKGROUND

In 1983 the Governor of Indiana, aware of the changes brought to the state's industrial-agricultural economy by the high-tech age, formed a Consortium for Computer and High Technology Education to act as advisors to the Department of Education. This group of visionaries planned a two-year program involving many facets of education with technology. Particular emphasis was placed on the need to prepare a statewide school staff, showing the mid-forties as a median age, to use computers in the classroom. The Legislature funded that program and has continued to allocate monies to the Consortium at the Department of Education's request.

OUTLINE OF APPROACH

After the initial training of 20,000 teachers with hands-on experimentation of what a computer can do, it became evident that many teachers went back to schools which had no computers in the classroom. It is of note that, over the last five years, the ratio of students to computers in Indiana has improved from 45/1 to an estimated 25/1.

At that time, the educational community was tiptoeing through the emotional as well as factual quagmire presented by statements such as "Computers are just a fad", "What computers should we buy?", "There is no software!".

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In 1985, the nine official Computer Training Centers located throughout the state offered more specific training on what computers could do for the students. Development of modules on curricular areas such as language arts, social studies, science and mathematics was judged imperative to obtain speedy adoption in the classrooms. Application software of generic nature was selected to address the requirements of any hardware available in the schools.

For two years teachers and administrators came to the centers to study and plan how the technology, computers at the time, could be used as an integral part of a curriculum.

The staff preparation in Indiana has, thus, progressed through three phases:

1. What can a computer do? (1984-85)

2. What can an educator do with a computer to benefit students' learning? (1985-87)

3. How can the technology be used by teachers to encourage students to develop thinking skills and at the same time streamline teachers' administrative duties? (1987-)

The third phase requires a fine tuning of the previous workshop modules and is a customization process done by the four consultants of the Indiana Computer and Technology Consultant Program.

DEVELOPMENT OF MODULES

The development of the modules is directed at two main goals:

- guide teachers to work with available software in a pedagogical context within a familiar framework;

- prepare teachers to accept the effects the use of the state-of-the-art technology will have on their own and their students' approach to the learning process.

Consideration is given to

(1) flexibility and adaptability,
(2) logical extension to other technologies,
(3) easy replication by school systems,
(4) changes from conventional instructional methods.

(1) The modules emphasize the concepts of computer hardware and application software use. Hands-on workshops using a particular hardware or software product can then quickly be molded around a core module. Some modules address an educationally sound and effective management of a classroom using limited computer availability such as 1 computer/1 teacher/30 students which is a common scenario in the schools. A main objective of the modules is to offer to all involved, regardless of their background, an experience where professional growth is an immediate reward.

(2) In the development of new modules, there is an awareness that the pattern and idealogies being used are applicable to in-services on the use of technologies such as CD-ROM, interactive video, graphics capturing devices, telecommunications, scientific probes and the future non-thinkables. Many of the modules presently in use would require very little change to satisfy the needs for such directions.

(3) The modules are offered for use by teacher-leaders who train their school staff. It is necessary that the steps shown in the modules be sequential for the adult learning processes and be easy to follow by one who is not the developer of such a module. The rapid changes seen in the technological use in many school districts with which training was done, attest to some success in the replication efforts.

(4) The modules since their inception have always included suggestions on development of pertinent lesson plans including the computer usage, practical examples and proven didactic strategies. They also list, when advisable, resources, bibliographies, comparable software.

RESULTS

One interesting outcome of the development of these modules is that new modules can be built with materials already available in other modules. The use of these modules in the statewide efforts to bring educators to accept and use technology as a medium of importance in the educational arena, is shown to be a catalyst in bringing some teachers and administrators to question and envision the possiblity of changes in the next century. To paraphrase John Kenneth Galbraith, there is a mood in the Indiana schools "to want to change things, to want to see things happen and to not want to just talk about them".

IMPLICATIONS FOR THE FUTURE

The gradual build-up of a cadre of teachers using materials developed and implemented by our consultant program to train other teachers is one component of a program under development by the Consortium called the Advanced Educational Technology Diffusion Team Training program. Modules will be developed that can be used to provide local school district teams with leadership-planning and change-agent skills required to deal with educational technology advancement.

A consortium funded project called "A Slice of Tomorrow's School" involves two school districts working to develop a restructured educational system for implementation next Summer. This project includes not only curriculum and management development but significant teacher/staff development program. The State Technology Consultant program is working hand-in-hand with these schools to insure adequate resources for a notable effort.

Existing modules have also been adapted and used to provide training for teachers, students and parents in the Indiana Computer-in-the-Home project, where we are extending the use of educational technology into the homes in hope of expanding learners' time-on-task as well as increasing students' productivity and parents' involvement.

In all future plans for the use of technology in education, the staff development process is a first priority. A well-conceived, open-ended plan for the materials to be used for a successful outcome to this process is essential. Indiana is showing that it can be done. In four years, it has been possible to bring teachers to accept that they will be agents of change and will be empowered to show what they can do to bring such changes to their students.

COMPUTING IN CAREERS/CAREERS IN COMPUTING
A KIT FOR TEACHERS, COUNSELORS AND VOLUNTEERS

J Lawson , D Carey

ABSTRACT

Knowledge of the training requirements, salary expectations, and potential for advancement in a wide variety of computer careers should be made available to all students at the junior and high school levels There is evidence that carefully planned, well integrated career counseling helps students make more realistic career choices, succeed in completing their preparation and accepting positions in their chosen career.

The Education Board of the Association for Computing Machinery (ACM) commissioned a seven-member task force to develop a plan to deliver current, accurate information on computing in careers and careers in computing to secondary students. The task force has produced a kit of materials and activities for use by teachers, counselors, or computer industry volunteers with students in grades 7-12

There are three primary objectives for the Careers in Computing project:

- to provide a comprehensive package of current, usable information on careers which utilize computers daily:
- to provide teachers and counselors with means of locating and using resources in technical career guidance:
- to encourage greater involvement by representatives from the computer world outside of schools.

The kit materials consists of a videotape, class sets of several brochures, bibliography of resources copy masters for presenters, and a presenters manual with classroom activities. Plans call for the production of a training videotape to be released in March 1989 which will describe the design philosophy of the kit, showing presenters using each of the activities with typical classrooms. Brochures included in the kit contain pictures job responsibilities, training requirements and brief interviews with typical workers in a variety of job categories.

The Presenters manual is a loose-leaf guide to suggested uses of the kit. It contains an inventory list, hints for successful presentations, 12 suggested activities for students, the bibliography of related materials, and a form for recording the number of uses of the kit.

Plans call for distribution of a minimum of 100 kits per year in the 88-89 and 89-90 school years. Distribution will be based on geographical diversity, type of school, and commitment to use the kits as demonstrated by letters of support from school representatives

The session will present the materials in the kit, review the training video, and inform participants of how to obtain a kit.

ACM Task Force

University of Colorado

ADVANCED PLACEMENT COMPUTER SCIENCE TEACHER PREPARATION

Larry E. Liden*

ABSTRACT

The Institute of Computer Technology, a public school specializing in facilitating education about technology has developed a two-phase approach to the problem of finding more teachers able and willing to teach computer science in high school. In partnership with computer specialists from a number of high technology companies, the Institute has produced curriculum guides which provide all of the materials, visuals, lab exercises and worksheets necessary to teach A. P. computer science (as well as similar course materials in C Language, Using a Microcomputer as a Productivity Tool and Logo in the Elementary Curriculum). These materials dramatically reduce the preparation time and effort required to teach these subjects. The Institute then developed intensive week or two week long workshops to help teachers use these materials with confidence and enthusiasm. These workshops were offered last summer to teachers from throughout the nation and an expansion of the program is being planned for the coming summer.

ABOUT THE INSTITUTE

In recognition of the need to provide up-date training about rapidly changing technology, the State of California, three school districts and over fifty high technology firms in the Silicon Valley have formed a unique partnership dedicated to teaching about technology; to facilitating the teaching of technology in schools throughout the state; to experimenting with innovative teaching techniques and to fostering a partnership between education and industry.

The Institute of Computer Technology, as this partnership is called, is authorized as a public school in California. It offers, to students from kindergarten age through senior citizen, classes ranging from computer literacy to advanced computer languages and applications. It draws students from a wide geographic area to classes after school, on weekends, holidays and during the summer. Instructors come from industry and various public and private schools and colleges and are all employed on an hourly basis as needed. Free of the responsibility for basic education and such restraints as the need to match classes to full-time faculties, traditional class hours and calendars, problems of discipline and motivation, poor teachers and pressures from diverse community interests; ICT is able to experiment, to develop and test new curriculum and teaching techniques and to attract the very best teachers who enjoy the satisfaction of teaching in such an environment.

The program has been a huge success. In the four years that the Institute has offered classes, over 51,000 students have attended classes which range in length from five hours for basic computer literacy to 150 hours for advanced placement computer science. ICT has attracted the support of many industries of all sizes, has amassed a pool of technical and teaching talent that is incomparable, and has attracted visitors from all over the world.

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CURRICULUM DEVELOPMENT

This success led to the desire to extend to all schools in California the benefits of ICT's partnership with industry, the gold mine of talent thus assembled and the ability to experiment and take risks. ICT was asked to use its contacts with industry to develop materials that will make it easier for schools to prepare students for a technical world. With funding under legislation co-sponsored by State Senator Rebecca Morgan and State Assemblyman John Vasconcellos, the Institute has produced curriculum materials for advanced placement computer science, using a microcomputer to increase productivity in college or career and C language. In addition, to help with the larger task of teaching with technology, ICT has produced a teacher tutorial to help integrate Logo into the elementary school curriculum.

The development process for all of these programs was remarkable in its extent, attention to detail, amount of effort required and amount of the testing and revision involved. The materials were developed in modules with a team of practicing computer scientists or application specialists and outstanding teachers assigned to each module. A curriculum development specialist provided by Hewlett Packard Company provided coordination and training to keep all groups working together. The initial efforts were reviewed by education experts for teachability, organization, and use of objectives. These materials were then tested as modules with small groups of six or seven students who were paid to take the course and to complete an evaluation of each lesson. After revisions, the modules were merged into a complete course and tested with a regular class taught by one or more of the developers. After another revision, the materials were tested in a regular class taught by a teacher who was not involved in the development and the materials were revised again. Then the materials were sent to a team of technical reviewers from local companies who reviewed the material for accuracy and relevancy. The materials were then reviewed by a professional educator and a technical writer from industry for accuracy, clarity, teachability, adherence to established objectives and appearance. In all, over 6,000 man hours were devoted to developing and testing the AP materials alone. Finally, the materials have been revised to incorporate new ideas, and suggestions from schools throughout the nation.

The materials are available to any school or individual for the cost of duplicating and shipping. Each book includes copyright release to make copies of student materials in whatever quantity is required. Currently, over 300 schools in the United States, Canada and Japan are using these materials.

The materials are proving to be an excellent aid. Teachers who have been teaching similar courses find they can pick and choose lessons to strengthen weak areas and that the transparency masters, tested lab exercises and references dramatically reduce the preparation time and improve the quality of their teaching. Teachers who are teaching the material for the first time find the timed lessons invaluable and report that they can plan their teaching with some idea of where they should be at any given time. They can save hours and hours of research time by using the content guides and suggested references, and teachers maintain confidence that the materials they are teaching are relevant and, in the case of the AP program, suitable preparation for the College Board exam.

TEACHER TRAINING

The availability of good teaching guides and materials is only one part of the necessary effort to improve the quantity and quality of computer instruction. Training is still critical. At ICT we identified three categories of training required for advanced placement computer science. Teachers who have no experience with Pascal require training in the fundamentals of structured programming, control structures, data types, procedures and functions and file processing. For this type of individual we offered a nine day workshop that assumed familiarity with computers and experience in a programing language, usually BASIC, and prepared individuals to the point where they could begin setting up a computer science curriculum for high school and teaching an introductory programming course using Pascal as the working language.

There are, we found, a large number of teachers who have had some training in Pascal but who need help with the more difficult subsets of the College Board exam such as recursion, arrays, sorting algorithms and string processing. For these individuals, we offered a one week workshop which prepared teachers to offer preparation for the Advanced Placement "A" exam.

Finally, a number of teachers have been teaching computer science but have lacked the experience to prepare students for the very advanced computer science topics such as pointers and related data structures, linked lists, binary trees, stacks and queues, hash-coded data storage and searches and binary expressions. We offered these topics in a two week workshop.

The format for all workshops was the same. The morning was spent in traditional classroom settings where the participants assumed the role of students and the ICT instructor used our curriculum materials to present selected lessons. In the afternoons, participants worked in the lab on the same exercises they would assign their students and the ICT instructor moved to an adjacent lab to teach the entire course to high school students. Workshop participants could, if they desired, observe the lessons being taught in an actual classroom situation. In the evenings, participants exchanged ideas, worked on mutual problems and helped each other. In addition, time was devoted to analyzing the College Board exam to give participants an idea of what was expected, how the exam was scored and what special preparation was helpful.

Since participants came from all over the state and nation, we arranged visits to the local high technology companies which have made the Silicon Valley famous. Finally, we provided some social time with to allow participants to develop friendships that will help them throughout the year.

The workshops were offered last summer and all were deemed highly successful. In our post-workshop evaluations, we concluded that the beginning workshop is least valuable because many people with this level of preparation require more than can be provided in two weeks. We may continue to offer it as a vehicle for people who need to gain confidence and practice or who need refreshing after some time away from programming, but we also recognize that local colleges and universities offer this kind of preparation and the longer time involved is helpful. The one week workshop for the "A" level preparation gained the best reviews from both teachers and participants. It seems to have been perfectly timed with adequate opportunity for practice, exchange of ideas and formal instruction. The two-week "AB" level workshop, we found, could be reduced in time. It appears that individuals with the prerequisite preparation can grasp the material very fast and do not need as much practice time. For the coming summer, we have decided to reduce this workshop to six intensive days which will allow participants to spend a week plus one day of the weekend. This will reduce the cost of housing for out - of area participants and still allow individuals who so decide to take both the "A" and "B" level portions.

We will offer the workshops for the direct cost of instruction only. The state funding provided ICT pays for K-12 students only but our non-profit status still allows us to offer this training at very low cost and thus help fulfill our basic mission of facilitating computer instruction throughout the state.

So far, our intensive training efforts have been devoted to AP computer science. We also offer longer workshops to help teachers use a microcomputer as a personal productivity tool and to prepare their students to use word processing, databases, telecommunications spreadsheets and graphing power to do college-level work. The curriculum we have produced is specifically written to avoid specific software or hardware, but our training programs involve Microsoft *Works* ™ on the Macintosh, and *Appleworks*™ on the Apple IIe.

Future development plans include teacher training for C Language and in desktop publishing as it can be applied to teaching situations.

More information on the workshops or the curriculum may be obtained by writing the author.

TEACHERS' AND CHILDREN'S USE OF EXPERT SYSTEMS

Ronald D. Owston*

ABSTRACT

While expert systems have proven beneficial in business and industry, they have yet to have had an impact on education despite their potential advantages as tools for teacher and student use. Two projects are described that make use of expert systems in the classroom, one in which an advisory system was developed to help teachers in the management of a local area computer network, and another in which children created their own knowledge bases using expert system shells. Both projects suggest that expert systems do have a valuable role to play in the classroom to help improve teacher productivity and to enhance student learning.

INTRODUCTION

Expert systems have had a significant impact on business and industry. They are being used in such diverse fields as investment management, insurance underwriting, mineral exploration, and industrial design. Feigenbaum (ref 1) reported that within IBM alone more than 100 different expert system applications have been developed. Business and industry analysts typically credit expert systems with increases in productivity, distributing specialized expertise throughout the organization, systematizing decision-making, and making operations more cost effective.

The impact of expert systems on the field of education, however, has been minimal. Expert systems would seem to have the potential to help teachers manage their classrooms, design and plan instructional activities, improve teaching strategies, and diagnose student learning problems across all curricular areas. For students, expert systems can create learning environments in which knowledge can be explored and manipulated at will. Intelligent tutoring systems are one way in which this can be done. Ideally, these systems know how to teach, what they are teaching, and to whom they are teaching and, thus, can provide a rich interactive learning environment (ref 2). Another application of expert systems as a student learning tool lies in having students create their own knowledge bases using expert system shells (ref 3). When expert systems are used in this way, students must make explicit the classification schemes, multivariate reasoning, means-end analysis, and production rules employed on a given content domain to reach conclusions. The process of making explicit cognitive strategies such as these has been shown to enhance metacognitive functioning and promote increased problem-solving performance (ref 4).

In this paper, I would like to describe two projects which my research associate Herb Wideman and I have carried out--one involves the development of an expert system advisor for teacher use, the other looks at how children can develop their own expert systems.

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TEACHERS' ADVISORY SYSTEM

To date most expert systems developed for teacher use have been created within the context of a research project aimed at assessing their feasibility within a given domain. The goal of the first project that I wish to describe was different: an assumption was made that the development of an expert system advisor for network management was feasible. We wanted to first create a prototype system and study the problems associated with the prototyping, and then develop a working system for routine classroom use.

This expert system project was carried out in a large high school in Toronto. The school has a network of 130 Unisys ICON educational microcomputers connected to a cluster of eight fileservers, the largest network of ICON computers currently in use. These machines are distributed throughout the school in labs, as well as at individual sites for special purposes. Because of the uniqueness of the network, a large portion of one teacher's time was devoted to network maintenance and helping other teachers solve network related problems. Many of the inquiries the teacher/manager received were routine in nature and, therefore, were considered good candidates for inclusion in an expert system advisor. The first area we chose for incorporating into an advisor consisted of a set of problems related to students being unable to log on to the network. This was considered to be a good problem area to begin with because (1) it was one of the most frequently encountered difficulties, (2) it is a bounded area in which solutions to almost all log on difficulties are known, and (3) classroom teachers can correct most problems themselves once they know what steps should be taken.

My research associate and I were responsible for doing the actual coding of the knowledge base using the KES expert system shell on an MS DOS machine. We relied on the teacher/manager as domain expert to provide us with a description of the problem area and the heuristics he uses to solve network log on difficulties. One of the first problems we encountered in the development of the advisor was deciding on the format in which the teacher/manager would give us the domain facts and rules. Initially, we asked him to freely draw a tree diagram that would represent the knowledge domain. This did not prove satisfactory because it did not give him enough structure to guide his work. The result was that branches were left incomplete and actions were sometimes omitted. To give him more structure we provided him with a copy of Harvard Graphics, a graphics presentation software package that has an easy-to-use, menu-driven component for creating tree diagrams. This solution generally proved workable as it imposed more rigor in the drawing and resulted in neat, readable diagrams. A drawback of the package is that only several branches or levels of the tree structure can be displayed at any one time so that an overview of the entire knowledge base could not be obtained. We are still searching for a more satisfactory representation procedure, but so far we have been unable to find one.

We faced another dilemma in designing the system: whether to structure the knowledge base so that the end user is presented with a series of binary questions (e.g. Can the student log on at another terminal? Yes-No), or whether to structure it so that multiple choice questions are presented (e.g. Student can log on at (a) another terminal in class, (b) another terminal in school, (c) no other terminal?). The former format is easier for users to answer, yet it is not as efficient a way for the computer to arrive at a diagnosis. The latter format, while more demanding and, perhaps, intimidating to the user, requires less coding and processing time. We ultimately chose to use the binary format because the knowledge base was not particularly large and thus efficiency was not a serious concern, and because we sought to make the advisor as user friendly as possible.

During the knowledge base design we encountered diagnoses that would have been too complex for teachers to implement. We handled this situation by giving the user the message "See the network manager". An attempt was made to minimize the number of times this diagnosis appeared so that teachers would not view the advisor as unhelpful and so not bother to use it, going instead directly to the manager when they encountered log on problems.

While the network advisor is still undergoing development, early indications are that the system is usable and will likely result in increased productivity for teachers by helping them to rapidly diagnose network problems and relieve the network manager of some routine work. Further data will be collected to see to what extent these early indications can be supported.

CHILDREN'S EXPERT SYSTEM DEVELOPMENT

The second project that we carried out involved the development and use of expert systems by 11 to 13 year old children. (A more complete description of this project and its rationale can be obtained from reference 5). Given that expert system shells allow users to structure their own expert systems by means of menu-driven interfaces and English-like rules, we were interested in testing the feasibility of using expert systems with younger students and examining some of the processes and outcomes related to student development of expert systems. Our study took place in a grade seven class of a senior elementary school outside of Toronto. Students accessed the IBM Expert System Environment on York University's mainframe computer via modems and two microcomputers in their resource centre.

Together with the science teacher (who had limited experience with computers and no background in expert systems), we planned a 17 hour unit of work on expert systems that integrated into part of their science curriculum which focussed on the classification of living organisms. First, the teacher introduced the unit with a discussion of classificatory systems in general, and demonstrated how a simple prototype expert system could be used for classification. My associate and I then took the students through the construction of a simple expert system designed to classify two-dimensional objects. The class was next divided into ten groups of three, and each group entered this simple knowledge base into the computer and debugged it. We concluded this introductory phase of the unit by having the student groups develop another simple expert system based on an example of a scheme for classifying common sports.

The main task of the unit, which was to develop an expert system to classify living organisms such as birds, fish, plants, and mammals at the class, order, and species level, was begun next. Each group was given a different assignment and a set of research materials from which they could extract the necessary classificatory keys and information. Before the students started we modeled a similar assignment by showing them how to use the reference materials, how to develop the classificatory keys, how to delineate the neccessary parameters and rules, and the way to draw the tree diagram. As students worked on their assignments, the researchers and the teacher helped groups as needed by mediating their discussions, asking questions, and offering hints.

During and after each class period we wrote detailed notes on the classroom interactions and activities that occurred when the students were working both on and off the computer. In addition, throughout the project we conducted informal interviews with the teacher and with individual students or groups of students. Our aim was to develop a "thick description" of students' experiences and work processes as they engaged in their expert system projects, and from these data to develop working hypotheses using qualitative data analytic techniques.

By the end of the time allotted for the unit, all but one of the groups was able to complete their expert system. On the whole we found that the development of simple rule-based expert systems can provide a valuable educational experience at an age earlier than one might expect. Students were able to interact with the expert system shell with considerable ease after a short period of familiarization. Furthermore, we found that the project required students to develop a deep understanding of the interrelatedness of taxonomic strata and keys and of the procedures for rule-based classification. Our observations suggested that the project activities did, indeed, promote students' acquisition, practice, and extension of their cognitive and metacognitive skills.

We concluded from this study that student development of expert systems could likely be undertaken in any subject domain provided certain constraints are kept in mind. These include providing adequate time for planning and implementing the unit of work, introducing the unit gradually with many concrete examples and hands on activities, providing adequate assistance to students as they are working, and structuring the unit to allow group work.

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PREPARING COMPUTER-USING EDUCATORS: AN UPDATE

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ABSTRACT

The Northwest Council for Computer Education (NCCE) funded this project to develop an updated set of competencies which might be used as guidelines in reevaluating teacher education programs. Nine categories of competencies were developed: general competencies for all teachers in (1) elementary school, (2) middle school, (3) high school; specific competencies for teachers teaching about computers and computing (computer science) in (4) elementary school, (5) middle school, (6) high school; specific competencies for district/building computer curriculum coordinators for (7) elementary school, (8) middle school, (9) high school. Classsroom teachers, curriculum coordinators, and computer coordinators at all levels served as evaluators to identify the guideline competencies in a four-round Delphi approach. Since this paper was prepared prior to the completion of the project, the final set of competencies will be presented at the conference. Additional copies may be obtained by writing the author.

INTRODUCTION TO THE STUDY

The integration of computing technology into the American society has resulted in a strain on the educational system. Since early in the 1980s, education has struggled with the complex issues of preparing computer literate citizens. Yet, despite the huge purchases by many schools, the recent National Assessment of Educational Progress (NAEP) project titled "Computer Competence: The First National Assessment" indicates that schools have only dented the ignorance most students and teachers have of computers. The study of over 20,000 students in the third, seventh and eleventh grades found that "schools have failed to use computers effectively and teachers are trained inadequately." According to Marc Tucker, President of the National Center on Education and the Economy (ref 1), "The difference is between knowing a little about the computer, and being able to use it effectively. Few American school children can do the latter."

The problem is not one that can be corrected with additional investment in hardware and software. The problem is one that requires an investment in the education of teachers. During the past ten years, many teachers have been asked to teach about the computer at the elementary, middle and high schools; furthermore, they have been expected to assist students in using the computer as a learning tool. Their preparation for teaching with and about computer technology has largely been from their ability to teach themselves. Typically, they have not had an extensive computer education.

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In fact they have not experienced learning with the computer. Yet, they are expected to integrate computer methods among a variety of instructional methods. And, of even more concern, they have been expected to "create" computer literacy course work as well as teach it.

The results are certainly represented in the NAEP assessment. The approach has led to a curriculum that is highly dependent upon the teacher's education. If the teacher enjoys programming, there is a course in programming. If the teacher understands word processing, there is a course in word processing. If the teacher knows Logo, students might be allowed to explore mathematics in a Logo environment. It is common to have computer literacy courses available at a school one year and not the next simply because the teacher changed schools. Some schools attempt to keep these courses by assigning another teacher. The instructions for the other teacher are to "learn with the students." The approach is ensuring an unequal education.

Clearly, it is time to reassess the educational needs of teachers. But, what guidelines exist for this reassessment? This project proposes to develop guideline competencies that will assist teacher education programs in this effort.

BACKGROUND

In 1983 NCCE funded a project to develop a set of competencies which might be used as guidelines in developing teacher education programs to prepare teachers in the use of computers in education. Moore (now Niess, ref 2) directed the project that provided preparation recommendations for (1) all teachers, (2) teachers capable of teaching about computers and computing at the elementary school level; (3) teachers capable of teaching about computers and computing at the secondary school level; and (4) district/school computer curriculum coordinators capable of planning, developing, organizing, and directing computer science programs for districts/schools. The guideline competencies were published nationally, and many teacher training programs were able to use the competencies to discuss and develop courses/programs to prepare teachers in the use of computers in education.

Computing technology and its influence on education has significantly changed since the development of the original guideline competencies. Widespread and everyday use of application packages including word processing (with spelling and grammar checkers), data base systems, spreadsheets, and graphics packages have altered not only the manner in which teachers and school administrators do their job, but also the nature of the computer curriculum. Nationwide the curriculum is emphasizing learning to use the applications of computer science rather than learning computer programming. In 1983 telecommunications was not even considered in the development of the competencies. Yet, today, many schools provide some instruction in this area. Where do the teachers learn about telecommunications? Should they have some experience with telecommunications in their preservice education?

The changes that are taking place are likely a reflection of the nature of the marketplace and integration of the technology into everyday lives. Clearly, societal forces have escalated the pressure for citizens who can make good use of computer-based aids; to meet this pressure, students must grow up using computers and must receive appropriate education in their uses. Thus, in the past five years, more teachers in all disciplines and at all levels, have been required to become involved in computer education.

The International Council for Computer Education (ICCE) Teacher Education Committee (ref 3) proposed that "When making recommendations on teacher education for computer education, a minimum of three audiences must be considered: (1) all teachers, (2) computer science teacher, and 3) district/building computer coordinators. In addition, any set of recommendations must consider the special needs of the elementary, middle and high schools and have a unifying theme emphasizing the concept that the computer is a problem solving tool for use throughout the curriculum." Furthermore, this committee suggested that all future teachers should be learning about (1) the computer as a system; (2) computer applications in education; and (3) the computer as a tool for personal use.

Teacher preparation for computer education typically recognizes many of the competencies recommended in the original project. Many teacher preparation programs require that the preservice teacher demonstrate competence in using computers in an educational situation. However, in light of the NAEP assessment and the changes in the past five years, it is time to reassess those requirements. More importantly, an updated set of competencies could serve to encourage (1) teacher preparation programs to reevaluate their computer education programs;· (2) teachers to reevaluate their own competencies and preparation; and (3) educators to reassess the progress that has been made in computer education and the preparation of teachers to meet the changes.

PROJECT DESIGN

The goal of the project is to develop a set of competencies which might be used as guidelines in updating/developing teacher training programs to prepare teachers in the use of computers in education. Nine categories of competencies were developed through a modified Delphi technique:

	ALL TEACHERS	COMPUTER TEACHERS	COMPUTER COORDINATORS
ELEMENTARY	1	4	7
MIDDLE	2	5	8
HIGH	3	6	9

At least 20 specialists developed and evaluated the competencies for each category. The specialists were selected from Oregon and Washington including classroom teachers at each level, computer coordinators at each level, curriculum coordinators at each level, and administrators at each level. Consideration of different sizes of schools, different geographical regions, and different types (districts versus schools) of institutions were also considered in the selection of the specialists. Thus, the specialists represented the variety of educational situations throughout the Northwest.

The first round of the process presented the specialists with the set of competencies that were identified in the 1983 NCCE competency project. Suggestions from the ICCE Teacher Education Committee were also presented for consideration. The specialists were asked to prepare a list of competencies that they believed ought to be included in the identified cell. They were allowed to select competencies from the previous set, to edit some of those competencies, and to identify new competencies.

The second round combined all the responses from the first round. Specialists were asked to judge the sets using the scale of 1) Strongly Agree, 2) Somewhat Agree, 3) Neither Agree Nor Disagree, 4) Somewhat Disagree, or 5) Strongly Disagree. The specialists were also asked to add any competencies they felt had been overlooked and to clarify any competency they felt was confusing, unclear or misplaced. The mean rank for each of the competencies within each category was computed for the next draft. The competencies were ordered according to rank within each category. The editorial changes and the additional competencies from the second round were included in this draft. For the third round, the specialists were asked to indicate their judgement using the same scale. They were also allowed to edit and add competencies.

The final draft of the competencies within each category was identified using the mean ranks from round three. All categories were placed in a single document and sent to the entire group of specialists for a final ranking using the same scale. Mean rank scores were calculated for each item in a category. The final set of guideline competencies recommended by this project were ordered and presented including the mean ratings.

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SPEECH RECOGNITION: SOME PROBLEMS AND SOME SOLUTIONS

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ABSTRACT

Speech recognition systems have to date been based on pattern matching approaches. Alternative knowledge-based approaches have failed to mature as rule-based implementations. The status of speech recognition systems based on stochastic models is highlighted here to demonstrate the need for implementation of a feature-based or knowledge-based approach within a stochastic modelling framework. The use of specific speech features in sub-word hidden Markov modelling of speech is shown to give improved performance in speech recognition, to reach accuracies suited to speech and natural language understanding applications.

INTRODUCTION

Early approaches to automatic speech recognition were based on isolated whole-word pattern matching schemes and these tended to be for speaker specific operation with limited vocabulary (100 words), mainly due to extended training times since each vocabulary word needed to be individually trained by each speaker. Whilst such systems generally involved representation of the speech signal in a spectral form suited to the input speech, they have been termed "knowledge free" since they include little or no knowledge of specific speech events. However, by use of sophisticated pattern recognition algorithms, the performance of these systems has proven to be adequate for isolated word recognition in a variety of applications (ref 1). Knowledge-based or knowledge-rich approaches offer the promise of improved system performance in terms of recognition accuracy; improved user acceptability in terms of speaker-independent operation; and most importantly in terms of permitting use of natural, continuous speech. These knowledge-based approaches can be further divided into (explicit) rule-based implementations and (implicit) stochastic or statistical classification implementations. Both alternatives may exploit appropriate features of the speech waveform as identified by expert phoneticians (ie. they are feature-based). This paper will highlight the use of phonetic features within a sophisticated stochastic classification framework as an effective technique in speech recognition system design.

PROBLEMS IN SPEECH RECOGNITION

Although speech can be described phonetically by of the order of 50 discrete symbols (phonemes), the characteristics of a given instantiation of each phoneme will be affected by several factors. These include intra-symbol variability due to word boundary assimilations where phonemes at word boundaries interact, such as "red and blue" being pronounced "reb-am-blue"; differing levels of formality in speech resulting in different reduced pronunciation forms such as "actually" being pronounced "aktuli"; and differing intonation and stress patterns from different sentence constructions - all within a given accent and given speaker. The problems of inter-accent and inter-speaker variability further confuse the issue. In addition, the

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problems of acoustic contamination due to acoustic noise sources such as room reverberation, equipment noise and competing talkers exist. At a higher level, the problems of speech disambiguation produced by homophones involves the use of linguistic knowledge at a syntactic or semantic level. Use of such knowledge has been shown to be particularly feasible when the domain of the speech recognition task can be constrained. It is the explicit use of this higher level knowledge within the speech recognition system that introduces the possibility of speech understanding. In this context, the speech is a medium of communication between man and machine (a modality for man-machine interface) and is used to convey a concept, idea or message from an originator to a receiver. Speech can be considered as an acoustic manifestation of the concept or message and it is the understanding of the message by the receiver which is ultimately of interest. The degree of understanding as perceived by the originator can be gauged by the appropriateness of the subsequent response or action of the receiver or alternatively by modifications to the succeeding messages prepared by the originator.

In speech recognition systems based on whole-word recognition, the problems of word boundary assimilations and reduced forms can be minimised by training the system using the expected pronunciation form and by arranging for short distinct pauses between words. Use of such isolated word recognition is ultimately unnacceptable for a wide range of speech interface applications, especially for untrained users. Recognition of continuous speech, assuming vocabulary-independent model generation for the speech symbols, demands use of sub-word units defined in such as way as to accommodate the above sources of variability. The early attempts at realising connected word recognition (ie systems trained with isolated words but able to recognise strings of these words when uttered in connected/ continuous form) involved extension of the dynamic programming non-linear alignment methods used in isolated word recognition, via a range of "level building" optimisation paradigms. However, the performance of connected word recognition systems based on these approaches was in general too low (accuracy and vocabulary size) for most commercial applications.

Attempts to develop knowledge-based speech recognition systems date back to the 1970's in the ARPA Speech Understanding Project which attempted to use artificial intelligence techniques for knowledge representation to exploit speech and language knowledge within a rule-based computational framework. In these systems, the acoustic signal was first segmented and then labelled into phoneme-like units. The resulting phoneme string was subsequently used for lexical and syntactic analysis. Words in the lexicon were represented in terms of (appropriate) phonemic spellings, and syntax was usually described by conventional linguistic means. The performance of the systems was limited by the difficulty in reliably extracting phonetic information from the speech signal and incorporating this in an explicit rule-based structure based on a set of heuristically motivated rules. Such rule-based sytems have achieved restricted success, a major limitation being the difficulty in optimising the inter-dependence of the various levels of knowledge representation.

Recently the use of hidden Markov models to implicitly model speech units and lexical and syntactic data in a unified manner has achieved a high degree of success in the recognition of continuous speech (ref 2). In this system, sub-word models are concatenated to form word models which are then concatenated into sentence models, trained on the continuous speech. Work is underway to extend the 1000-word performance of this system to achieve an extensible 20,000 word vocabulary.

HIDDEN MARKOV MODELLING OF SPEECH

The principle of the hidden Markov model involves representation of the speech signal as a sequence of observation symbols or data vectors on the assumption that the sequence has been derived from a Markov process. The (hidden) states in such a model are related by a transition probability measure and each state can be characterised by an output probability distribution over the set of observation symbols. The technique can estimate the probability of all possible observation sequences in a speech pattern and by using a dynamic programming scheme can identify the most probable sequence of states within a model. Using one or more models for each class to be recognised (in continuous speech recognition at least one model per phoneme) the probability of a specific phoneme/word sequence can be estimated. The hidden Markov model can be based on either discrete output probability distributions or continuous output probability density functions. Both approaches use a Markov chain to implicitly model the changing statistical characteristics that exist in the actual observations of the speech signal. For the discrete hidden Markov model, vector quantisation makes it possible to use a non-parametric discrete output probability distribution to model the observed speech signals. The objective of vector quantisation is to find the set of reproduction vectors (the codebook) that can represent the speech signal with minimum distortion. The discrete hidden Markov model then models discrete observations. The continuous hidden Markov model uses continuous density functions to directly model speech parameters without using vector quantisation. The discrete hidden Markov model is more computationally efficient and requires less training data than the continuous model. However, with the discrete hidden Markov model, a problem exists in that there may be some information lost in the vector quantisation operations and the performance of the discrete hidden Markov model may be lower than for the continuous hidden Markov model.

SEMI-CONTINUOUS HIDDEN MARKOV MODELS

In the discrete hidden Markov model, the discrete probability distributions are sufficiently powerful to model any random events with a mixture Gaussian density distribution. However, errors are introduced by the partitioning action of the vector quantisation operations. The vector quantisation codebook can be modeled as a family of finite mixture Gaussian density functions such that the distributions are overlapped rather than partitioned. Each entry in the codebook can then be represented by one of the Gaussian probability density functions and may be used together with others to model an acoustic event. Use of a parametric family of finite mixture densities can thus be closely combined with the hidden Markov model methodology. The partition of the vector quantisation operations is unnecessary, and can be replaced by a mixture density modelling with overlap to minimise the errors. With each entry in the vector quantisation codebook represented by a Gaussian density function it is possible to offer the probability of an observation within all codebook entries into the hidden Markov model. This semi-continuous modelling approach (ref 3) thus combines the codebook distortion characteristics with the parameters of the discrete hidden Markov model under a unified probabalistic framework. The discrete output probabilities in any state of the model become the weighting coefficients for the mixture components in the decoding process. Use of the semi-continuous hidden Markov modelling approach has been shown to offer improved accuracy in speech recognition (ref 3), with further improvements available by incorporation of feedback between model and vector quantisation. In general within hidden Markov modelling approaches to speech recognition, only a single acoustic feature space (such as linear prediction based cepstral coefficients) has been employed for sub-word (phoneme) modelling, irrespective of the specific class of phoneme, consonant or vowel. However, in order to achieve high discriminability between phoneme models, use of appropriate features for respective phonemes offers improved performance since vowel and consonant events are produced by different vocal mechanisms. Consonants can be characterised by spectral envelope features and by their temporal variation. On the other hand, vowels can be characterised by formant frequencies and their local time variations, rather than by spectral envelope. Using this approach it has been shown experimentally (ref 4) that vowel recognition using discrete hidden Markov models can be significantly improved by employing time duration modelling in formant feature space for vowel models and cepstral coefficients for consonants.

HIDDEN MARKOV BASED SPEECH RECOGNITION SYSTEMS

Work on hidden Markov model based speech recognition systems has been underway within the IBM speech recognition group since 1972, based on a natural language, speaker dependent statistical modelling approach. A current real time system (TANGORA) has a vocabulary of 20,000 words and recognition accuracy at word level is 95% for speaker dependent operation, in this case with isolated words. In the IBM system, each word is composed of a sequence of phonemic units, each associated with an individual model. The model parameters are derived using a training set of 100 naturally occuring sentences which are uttered by a new speaker during a short (minutes) enrolment session. Work is reported underway at IBM to extend the operation of the system to accommodate continuous speech.

More recently, a 1,000 word recognition system for speaker independent continuous speech recognition (SPHINX) (ref 3) has been developed at Carnegie Mellon University, Pittsburgh. For speaker independent speech recognition, the training database consists of 4200 sentences specific to the task, spoken by 105 speakers. Here function word dependent phonemic models and generalised triphone hidden Markov models are employed to achieve word level accuracies of 95% in a database query task.

CONCLUSIONS

From the foregoing descriptions of speech recognition technology and systems, it can be claimed that speech recognition capabilities have now crossed a threshold of acceptability in terms of high accuracy recognition of continuous speech in speaker independent fashion. Such performance signals the reachability of specifications for commercially-viable systems where full recognition and presentation of the uttered words, in pseudo-verbatim or transcription form clearly permits direct interface with natural language processing tools. The use of knowledge-based phonetic feature selection to optimise the performance of stochastic models and to identify the most appropriate models for a given task has been demonstrated as the foundation for such future systems design.

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TEACH: AN APPROACH TOWARDS INTELLIGENT CAI

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ABSTRACT

This paper presents an effort towards the design and implementation of an educational program according to ICAI techniques. Its components - knowledge network, teaching rules, diagnostic rules and student model are explicitly defined around the course-manager module, which controls the coordination of all the components. This approach allows the teacher to access and adjust each component according to the specific needs of the educational environment he is going to use.

Using these elements and a set of inferencing rules, it can produce a detailed instructional sequence, which is defined according to the particular needs of each student.

These features are discussed each in turn, looking at the general requirements/specifications and then following them through the design of a small prototype: TEACH. This prototype has two purposes: to examine the possibility of creating such a program and to explore, by extension, the generality between types of ICAI programs. In order to gain from the embedded inferencing capabilities, TEACH was implemented in Prolog.

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IS INTELLIGENT CAI PROGRESSING INTELLIGENTLY?

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Abstract

This paper tries to highlight concerns about a conflict between the aims of the ICAI community on the one hand and those of practising teachers and educational researchers on the other. Many systems produced by ICAI researchers seem not to relate to current professional educational opinion about the needs of schools: we explain why. The purpose of this paper is not to raise criticisms of ICAI for their own sake. Rather, the fundamental tenet is that the science required to enable machines to learn is not the same as that to enable computers to facilitate classroom teaching and learning.

INTRODUCTION

This paper is concerned with the role of artificial intelligence research in the use of computers to help teaching and learning. The (American) jargon term for computer systems which exhibit intelligence and help teaching and learning is Intelligent Computer Assisted Instruction, or ICAI; I prefer Intelligent Computer Assisted Learning, or ICAL. The reason for this is that, in Britain, the term instruction is usually reserved to mean training in a skill - such as flying an aeroplane, or operating some piece of industrial machinery. Thus, instruction is associated with a specific vocation. On the other hand, learning is the preferred activity in schools, which should enable children to think for themselves in any of the situations they may encounter as adults.

Instruction implies what psychologists speak of as the behavioural approach to teaching and learning. Many educators, including members of the mathematics education community for example, now believe behaviourism not to underpin the most effective way of concept learning. In mathematics, for example, it has been realised that you develop children's genuine mathematical thinking better if they understand how multiplication tables are constructed, rather than just have the ability to recall that the third member of the triple which starts with 6 and 7 is 42.

Put in a nutshell, the British preference is to avoid behavioural instruction involving drill and practice activities. Thus, we frown upon the 'get it right, get a banana, get it wrong get 2000 volts up the left leg' approach to learning. In effect, our educators now accept that learning is not just storing a fixed set of images. They admit that the art of comprehending new material requires an 'effort after meaning'. Thus, in reading a complex text, or acquiring new information, humans must assimilate the new material to existing concepts. The outcome of learning - what is stored in memory - does not duplicate exactly what was presented, but rather depends on both what was presented and the concept to which it is to be assimilated. People change the new information to fit their existing concepts, and in the process details are lost and the knowledge becomes more coherent to the individual. By the same token, the act of remembering requires an active process of construction; during recall, an existing schema is used to generate or construct details that are consistent with it.

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The difference between these two approaches may seem subtle, but to me it illustrates how we computing researchers can go wrong if we try to produce applied research without fully understanding the needs of the domain of application. Unfortunately, rather like being a politician or a member of the police force, teaching is one of those jobs which everyone believes they can do better than the professionals themselves. (The only major exception to this is perhaps in Japan where there is recent evidence to suggest that a heightened awareness in parents of the difficulty of teaching mathematics is one of the many factors which has contributed to Japanese schoolchildren's acknowledged world lead in mathematics ability).

In terms of computer systems, LOGO is the de-facto example of a highly non-behavioural (or non-skill oriented) learning aid. Others include desk top publishing packages and certain hypertext systems. Whilst many books (possibly out of a feeling of desperation) include LOGO under ICAL systems, that is clearly a nonsense. Few, if any, ICAL systems fail to be skill based. Thus PROUST is designed to help novice programmers learn Pascal programming skills. It can look at programs and spot even conceptual errors. STEAMER is an instructional tool for training engineers in the skill of operating large ships. It gives an on screen simulation of the steam engines of these ships so that trainees can try various combinations of engine settings to cope with given constraints. GUIDON is a tutoring system built on top of the medical diagnosis expert system, MYCIN. This embryo catalogue is at the root of my concerns. It makes me ask: is much of the most recent research on Intelligent Computer Assisted Learning one step forward, and two steps backward?

My position can be summarised by saying that I would view the majority of existing ICAL systems as focusing on skill-based behavioural learning. As the teachers in our educational community leave behaviourism behind, AI researchers have produced software to replace teachers based on behaviourism. The so-called intelligent part simply supplies the feedback part of the train - reward - feedback behavioural learning cycle.

WHAT ARE THE AIMS OF ICAL RESEARCH?

More than thirty years ago, the original aim of AI work was to produce machines capable of thinking. Having discovered how hard that is, the focus shifted to what machine models of thinking could tell us about the thinking process itself: cognitive science was born.

In the same way, it may be that ICAL research began with trying to learn about the teaching and learning process by the construction of computerised models. Perhaps it still is. In any case there is a need to address the question of whether the focus indeed is, or should be, on behavioural learning. If, on the contrary, ICAL is intended to contribute to the classroom apparatus for teaching and learning then it is my contention that there is still a long long way to go.

Some researchers have become increasingly confident in their ability to simulate what they think is current classroom practice. One of them, Professor Alan Lesgold of the University of Pittsburgh, published the following remark in an OECD report entitled 'Information Technologies and Basic Learning':

'display cognitive science ... is beginning to have sufficient power to drive the development of intelligent computer systems that can engage in rich interactions with a student and promote learning .... Together, the tools and rigorous methods of cognitive science offer the possibility that computer systems can be vested with sufficient intelligence to function as major teaching tools, supplementing and enhancing a teacher corps whose numbers are insufficient and whose members vary in capability .... Those computers can not only teach but also serve as examples of effective teaching from which others can learn.'

Put another way, this implies that we now have computer systems which deserve to replace teachers on the basis of the quality of their teaching. Which are they? And do any of them relate to teaching domains other than skill acquisition? Even Wenger's important book [ref 1] says that ICAL is about knowledge communication: yet another behavioural paradigm.

Certainly I have seen the advantageous use of systems resembling DEBUGGY to train teachers in thinking about how to teach the skill of subtraction. Against this 'success' must be set Self's remarks [ref 2] about the problems of designing a computer program which will give children subtraction sums to do, and then point out what has gone wrong when they make errors. How would you create such a program? Which paper and pencil subtraction method should be programmed into our system? Just one certainly won't do because there may be a pupil who has just come into the class from another school 500 km away. It follows that you would need to construct a list of as many different subtraction methods as possible. Whilst several ICAL systems exist which attempt to tell children where they've gone wrong in the application of more or less traditional subtraction algorithms, no computer program could cope with every possible subtraction method: indeed a program will be just as confused as a human teacher.

But fortunately there is no need, for the British PRIME project has demonstrated that the teaching and learning of paper and pencil subtraction methods are obsolescent thanks to the electronic calculator. Wouldn't it be a good idea to devote our energies to computer systems which abolish problems in this way rather than try to resolve the existing difficulties?

My fundamental point is that there is considerable difference between producing a computer system which can teach skills - like those taught by PROUST, GUIDON and STEAMER - and a computer system which could take over the multi-faceted (and quintessentially concept forming) role of a teacher in a school classroom.

If you believe in the constructivist theory of learning, for example, it is vital that children themselves have control over their own learning. Many extant ICAL systems do not allow pupils this control. Unless a child adopts one of a fixed range of methods, it is usually the case that a child's idiosyncratic method will confuse an ICAL system. But because of our belief in constructivist rather than behavioural learning, we actually want to encourage each child to adopt his or her own method since, ipso facto, this will be more readily assimilated into that child's existing concepts.

SOME SPECIFIC ISSUES

Intelligent Tutoring Systems

A sub-family of ICAL systems is exemplified by MicroSEARCH which addresses a set of problems in which the solution is to be found by searching a tree of possibilities: those who are good at this kind of problem seem to search the tree more efficiently than others; some people don't even seem to be able to recognise what the branches of the tree are at the first level. Consequently, an Intelligent Tutoring System (ITS) attempts to increase awareness of the search space by making it explicit.

Thus, an ITS to help someone learn how to simplify algebraic expressions lists all the possible simplification methods and waits for one to be chosen. Then the system either applies that transformation to the algebraic expression or explains that it cannot be applied to the expression currently under consideration.

Creating the list of transformations which might be applied is an intellectually and educationally challenging task. Simply choosing one from a list is a mere behavioural activity. Hence I would view such an ITS as entering the learning process too late: when, essentially, all the genuine educational activity is over. Rather than spend energy producing such a system so that humans can be trained to work like a machine, wouldn't it be better to put the effort into an algebraic manipulation package for schools which does the grind for the pupils and leaves them free for genuine problem solving activity?

Heuristics for controlling the search through a problem space are perhaps one of the core issues of the confusion between the goals of Machine Learning (what Michalski calls implanting learning capabilities in machines) and those necessary for school classroom relevant ICAL. Thus, while the BACON project fairly clearly represents a useful move toward achieving the goals of machine learning, it may have much less to offer classroom ICAL. BACON's authors are relatively coy about the effect of noise on BACON's reasoning. Later versions are claimed to be quite stable with respect to noise. But our claim is that real data generated by a real pupil in a real discovery learning situation doesn't just contain noise: rather, it is often largely composed of irrelevant and incorrect data. Can BACON cope with the harsh reality of the classroom? From the published material about the system it is hard to say. But even if it could, history has shown that we humans sometimes learn better from the noise than from the correct data.

Student Models

Most, if not all, student models in ICAL systems do not consider affective issues. Yet is knowledge of your pupil's feelings that much less important than knowing what they know about the subject matter? If so, why is it that a given pupil will 'get on' with one teacher and fail with another? Is teaching possible without control over motivation? Certainly teachers of undergraduates have (and, possibly, need) less motivational control than teachers of moody adolescents. Has the researcher's university perspective incorrectly flavoured the student models of school classroom oriented ICAL systems?

Suppose we had a perfect student model in the de-facto ICAL sense; would this be enough? Surely, a teaching strategy must be based not only on what the pupil knows (I would prefer to say, not only the given pupil's ability), but also on the structures that pupil uses to contain that knowledge and the process he or she uses to build knowledge from those structures. Then there might be some hope of realising how best to add to that student's knowledge. To date, ICAL researchers have generally separated students' viewpoints from their strategic and subject knowledge. Is it clear that this is constructive?

Reification

I am concerned that, seen in the wrong light, systems like ALGEBRALAND (and, for example, several Prolog conceptual debugging aids that I have seen) appear to rely on intellectual skills deeper than those actually required for the tasks these systems are in some way supposed to make easier. The reification involved tries to convert between abstract and concrete. But it may be that the difficulties students experience actually stem from the absence of any really suitable concrete model. The computer's role in these systems can then be seen as a tool which transforms a model which would be mentally unwieldy into something more readily useful to a student. If this is indeed the case, then this would certainly be a discovery new to real teachers: explanation by making things more difficult!

CONCLUSION

A very careful agenda for future ICAL research work, aimed specifically at solving classroom problems, is urgently needed - as is some careful assessment of the work completed so far in this context. Both of these will be worthless unless they are drawn up by a group of teachers and ICAL researchers working together. In the meantime, there is little evidence to convince professional school educators that ICAL is anything other than an interesting area of computer science research.

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TOWARDS THE DEVELOPMENT OF AN IDEAL 'INTELLIGENT' COMPUTER ASSISTED LEARNING SYSTEM.

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ABSTRACT

The main purpose of this paper is to describe the author's concept of what constitutes an ideal 'intelligent' computer-assisted learning system (ICAL). The assumptions upon which the system is founded are made explicit, that is, learning is a process which is experiential, personal and social. These assumptions lead to the development of principles which must be satisfied if a system is to qualify as an ICAL. The system architecture is outlined and the various components are discussed in more detail with limited examples from the state of developments within the various elements of the system.

INTRODUCTION

To date much of what passes as CAL has focused upon the 'product' of learning, that is, the acquisition of particular skills or a body of knowledge, as the primary source for their development. They concentrate on the most appropriate mode of instruction to achieve the product and, as such, are based upon a narrow view of what learning entails. If an 'intelligent' computer-assisted learning system is feasible then its development must be based upon the considerations of how an individual learns, that is, the processes or transactions that take place in a learning situation.

It is the contention of this paper that there are three main components involved in individual learning. These assumptions provide the underpinning for the development of an ICAL. These components are that learning is experiential, personal and social and that there is a learning cycle that involves these aspects which all learners go through in varying degrees.

To elaborate briefly on these assumptions. In learning as experiential the extent one learns from experience depends upon the degree one can relate that experience to a past experience through the process of reflection. This idea of reflection embodies such concepts as problem solving,

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inquiry and the so-called scientific method of thinking. But, more often than not, reflective thinking is normally characterised by 'confusion, hesitation, backtracking or going round in circles' (ref 1) Reflection then can be said to be the process by which one attaches meaning to, or derives meaning from an experience. The extent and quality of that meaning naturally depends upon the quality of one's reflection which is itself limited or enhanced by one's perception of the importance of that experience.

This leads to the second assumption that learning is 'the exploration and discovery of personal meaning in one's own perceptual world'. (ref 2) A persons perceptual world includes perceptions the person has about self, the present environment and past experiences. A perception is the way things appear to a person, the way a person interprets what he senses, the meaning derived from experience. The dominant influence upon the perceptual process is the person's perception of self. The self is the focus of meaning and is common to all that a person experiences and determines what is perceived. But if this self is to be influential then there are two other processes involved - self awareness and the acceptance of this awareness. These two processes are embedded in a social context which leads to the third assumption that learning is social. Much of what a person becomes aware belongs to social influences in the past which have become internalised. What an individual internalises appears to be influenced by the processes of imitation, identification and compliance. These processes can be considered as key elements of social learning

For any given learning situation these three aspect of learning are always involved with experience as the foundation and personal or social dominant depending upon whether the 'product' of the learning process lies in the cognitive, affective or connative domains. (fig 1)

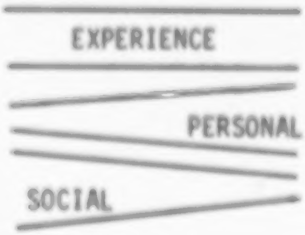

FIG 1.

From the assumptions outlined above one can derive the following principles upon which an 'intelligent' CAL system can be developed.

1. Learners have different prior experiences and thus different levels of knowledge.
2. Learners have different abilities and different learning styles.
3. Knowledge is personal in that learners attribute meaning or discover personal meaning.
4. Knowledge is both process and product.

Using the above principles the basic components of the ideal ICAL can be outlined.

SYSTEM ARCHITECTURE

Student model.

Any ICAL must have a model of the student in terms of a) cognitive style and b) current state of knowledge.

a) As learning is personal in nature each student has their own particular style of learning which is most effectivw for them (this is not to say that they cannot learn in other ways but that they have an optimum approach). Thw ICAL must take this into account and provide alternative approaches to match learning style with tutoring approach and knowledge representation to facilitate knowledge acquisition.

b) All students past experiences are not the same there fore it is necessary to establish the prior experiencew in order that optimum learning can take place. It must be noted that this aspect of the model is not dynamic for a students past experience will change as a result of interaction with the ICAL.

There has been some work done in this area (ref 3) but this is limited and there is still much to be developed and incorporated into a ICAL system.

NOTE It may be a possibility that an individuals learning style may change over a period of time as a result of experiences in other areas or as a result of thw interaction with the ICAL.

User Interface.

The most effective form of interaction must be the use of natural language and there have been some advances in this area but it is still early days (ref 4). Similarly if there is to be an emulation of the real world in terms of interaction then there must be a multi-media approach in terms of this interaction. Developments in the field of interactive-video and CD/ROM now make this aspect of the model a distinct possibility. (ref 5)

Expert Tutoring system.

There are a number of elements to this part of the ICAL system. There needs to be that part of the system which is capable of identifying the appropriate learning style of the student and then selecting the most appropriate tutoring strategy to match that style. This is essentially an expert system on teaching and instructional approaches. As such it should have all the characteristics of a good expert system.(ref 6)

A second sub-system must consist of a monitoring system that can assess the students past experiences and link in with the system that identifies the appropriate learning style in order to access the most suitable knowledge module. The monitoring aspect of the system continually updates the profile of the student. (ref 7)

Knowledge representation

This aspect of the ICAL system is the most problematical in terms of meeting the demands of the principles outlined earlier and, as such provides the stumbling block in the development of an ICAL. How does one represent the knowledge domain that allows different tutorial strategies to be implemented based upon users differing learning styles. How does one represent knowledge in such a way that takes into account individual perception and the attribution of meaning by the learner? Some criteria can be identified but these are clearly rudimentary. It would appear that there must be integration of 'procedural' and 'declarative' knowledge with indications of the relationship between these forms (ref 8). A modular base rather than a sequential format would appear to be appropriate with some reflection of the inter and intra-dependency of these modules.

If there is to be such a system as an ICAL it is evident that greater emphasis must be placed upon the concept of what constitutes knowledge and the most appropriate means of representing a particular knowledge domain. This would appear to support Gaines' plea for the growth of the knowledge scientist - a multi-discipline approach to the study of knowledge.

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MODELING THE STUDENT IN A TUTORING SYSTEM

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ABSTRACT

A basic subsystem of a tutoring system is the student model. We propose a student model using the buggy model and the overlay model. These two different conceptions are used independently or combined. The tools and the techniques used belong to the area of artificial intelligence. The proposed model can be dynamically developed, self modified and, in a great entent, topic independent. It interferes with the didactic processes so that the tutoring process is more effective.

INTRODUCTION

The main steps of a tutoring process of a courseware are:

1. The "description" of the knowledge level of a student for understanding the new domain (defined by the teacher).
2. The identification of the "the student level". For this identification the student is submitted to tests. By the answers given to these tests, the ability of the student to proceed to the new domain or not is clarified.
3. The introduction of the student to the new domain and the linking of this to the already known.
4. The adapting of the didactic procers not only to the knowledge level but also to cognitive capabilities of the student.
5. The correction of misconceptions (ref.5) and faults as well as their evaluation.

Thinking of the above mentioned procedure as a dynamic (ref.7) adaptive (ref.4) and interchangeable one, we use methods and rules from the domain of the artificial intelligence (AI) to create the student model (ref.3) Moreover by maximizing or minimizing parameters of the model, we can face one student or create teams of students depending on their knowledge and cognitive level.

There are two main concepts of a student model (SM) the "buggy" model (ref.2) and the "overlay" model (ref.2). The buggy model posits bugs, encodes information about bugs and misconceptions and corrects them. For the overlay model the knowledge is presented and the student is tested on both wrong and right. The problems for the creation of the one or the other model are different and the topics which can be effectively taught by the one or the other are different too.

In figure 1 a tutoring system is presented. It is obvious that there is a great interaction between the student model and the other parts of the system, namely:

The tutoring rules, the diagnostic rules, the knowledge data base, the communication and intercommunication model between system and teacher and student and model.

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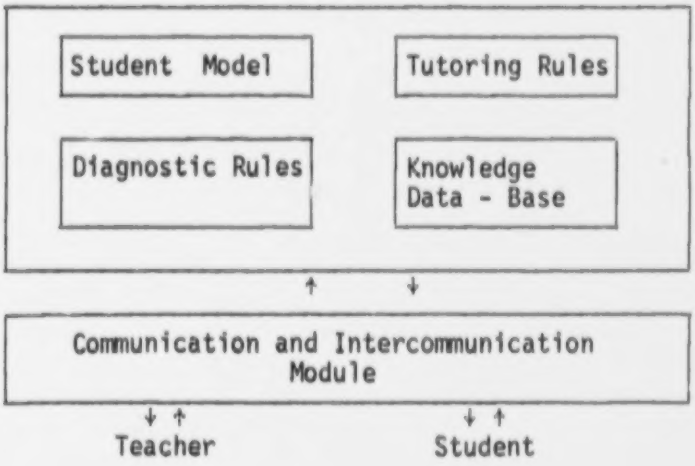

Figure 1. The Block diagram of an intelligent tutoring tool.

METHODOLOGY OF THE STUDENT MODEL DEVELOPMENT

The student model we propose is incorporating boths concepts:buggy and overlay model. There is an environment (ref.1) which must be constructed for the student model and which consists mainly of same knowledge data dases:

1. A knowledge data base of the taught domain.
2. A congitive data base containing the skills a student may have.
3. A bad knowledge data base containing the possible misconceptions that students may have.

The environment also contains tutorial strategies, a solver, diagnostic rules, therapy rules and rules of intercommunication.

The student model we propose will consist of rules picking up elements of the data bases mentioned and combining them to describe the student on a personal journal (ref.6). From this description the didactic strategy will be further affected.

The rules implelenting the overlay model will index across the knowledge data base and the part of the journal containing knowledge and ignorance elements of the student. The right answers will be given to the subsystem from the solver, in the case of a topic with algorithmic structure, of the teacher, in the case of other topics.

The rules implementing the buggy model will index across the bad knowledge data base and the part of the journal containing the mistakes of the student. For a mistake not contained in the bad knowledge base a special procedure will be followed. It will be evaluated by the teacher and then will enrich the bad knowledge data base.

There are other rules indexing across the cognitive (ref.8) data base to the corresponding part of the journal.

From the journal, the description of the student will be extracted. The description will ontain not only marks but elements as whether the mistakes are systematic or not etc. The parameters of this description will be linked with the subsystem of the didactic strategy affecting and changing it.

In figure 2. The block diagram of the student model is presented. The interconnections of the model are obvious.

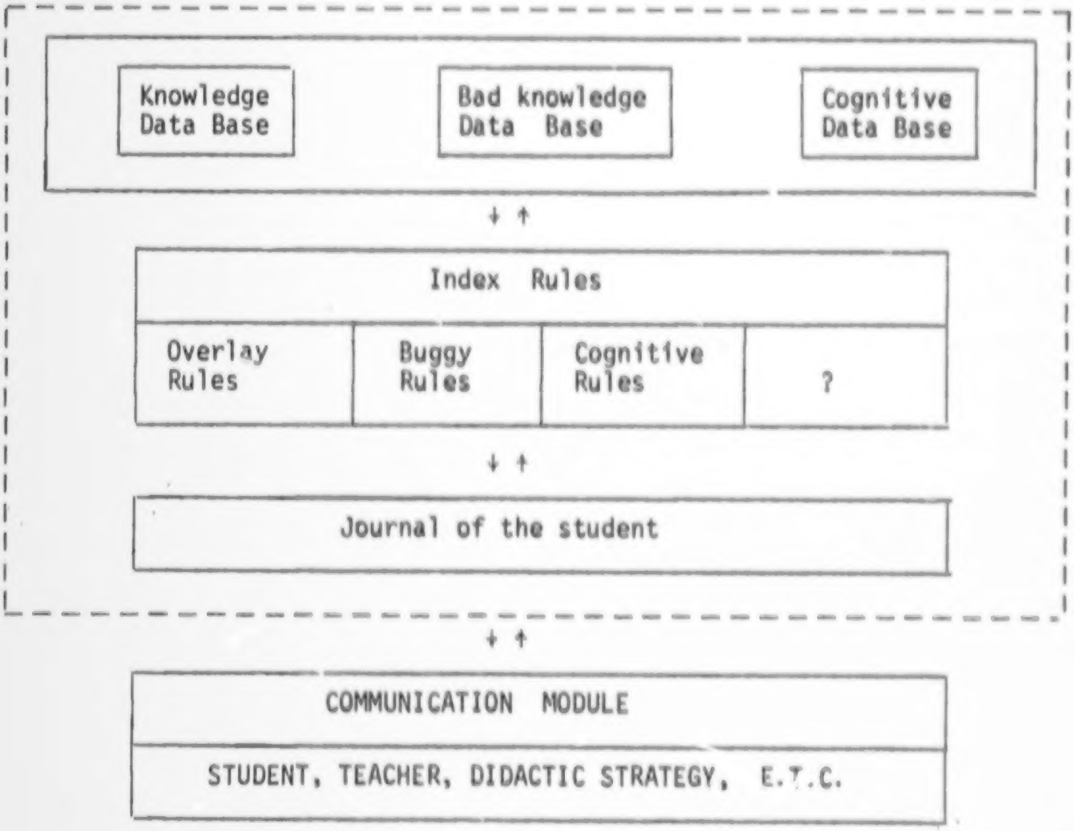
Knowledge Data Base
Bad knowledge Data Base
Cognitive Data Base
Index Rules
Overlay Rules
Buggy Rules
Cognitive Rules
?
Journal of the student
COMMUNICATION MODULE
STUDENT, TEACHER, DIDACTIC STRATEGY, E.T.C.

Figure 2. The block diagram of the student model.

IMPLEMENTATION - DISCUSSION

The first topic used for checking of the proposed model is Geography. It was chosen on the purpose of checking, first of all, the rules for the overlay model. We have created an experimental knowledge data base and a procedure for testing the answers. We use the language PROLOG for the implementation of the rules.

The journal can be used for statistical results and be very helpful for the teacher, too.

The idea of the implementation of the two models was mainly for making the model independent of the topic but it has proved very effective for the description of students different in capabilities. The data bases mentioned are faced as dynamical systems which will be enriched by a coding engineer as the use of the system increases.

We are going to check the model on other topics of different knowledge structure. The environment meeded for the model (solver, didactic strategy etc.) is faced on a parallel way by other members of the team of University of Athens.

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THE "CHARGE-FIELD" SYSTEM:A SIMULATION EXPLORING CONCEPTS IN CONSERVATIVE FIELDS.

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ABSTRACT

The "Charge-Field" system is a computer simulation with educational purposes for calculating and mapping electrostatic fields and for determining charged particles trajectories. The present status of the software and the educational purposes are described. The system is being designed to be used in the search for a methodology for teaching physical concepts using computer simulations.

INTRODUCTION

As an undergraduate project, a electron gun with electrostatic deflection was designed and built at the Physics Institute of the Federal University of Rio Grande do Sul (ref. 1). Using the know how acquired in that period, is now being developed at the Cognitive Studies Laboratory a simulation program to be used with educational purposes. This is part of the laboratory research efforts as a tool designed to help the search of adequate methodologies of interaction in the use of simulations by students in their learning process of the formal concepts envolved.

Basicaly the program allow the student to simulate the electric field configuration generated by charged electrodes as well as the movement of charged particles in the same region. Initialy the Physical-Mathematics model used is described, followed by a description of how the system works in practice. Coments are made on the educational purposes and in the present status of this research in our laboratory.

PHYSICAL-MATHEMATHICS MODEL.

The electric field configuration is calculated by solving the Laplace differential equaton in rectangular coordinates:

$$\partial^2 V/\partial x^2 + \partial^2 V/\partial y^2 = 0 \qquad (1)$$

where "V" is the electric potential to be calculated and "x" and "y" are the plane cartesian coordinates of the space where the potential is being determined. Despite the presence of free charges, that could determine the use of the Poisson equation, it is sufficient in our specific case to use the Laplace equation , due to the fact that those charges are present in small number and do not affect in a relevant way the field in what are immersed. The Eq. 1 is solved numerically by using the finite differences method with over-relaxation. The difference equations are written for non regular rectangular grids (ref. 2).

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For the trajectory determination were solved the particle movement equations in a plane where is defined a potential V:

$$\ddot{x} = \eta \, \partial V/\partial x \qquad ; \qquad \ddot{y} = \eta \, \partial V/\partial y \qquad (2)$$

where "η" is the charge/mass ratio of the particle, and the partial derivative of the potential give us the electric field component in the specific direction. Both are second order ordinary differential equations without the first order term. For the numerical solution was used the third order Runge-Kutta algorithm (ref. 3). The potential partial derivatives were also determined by the finite differences method.

SOFTWARE DESCRIPTION.

The system is composed of four units plus a manager program, all written in Turbo Pascal 4.0 for IBM-PC xt compatible microcomputers. The units are:

- Graphics editor and automatic grid generator.
- Mathematics procedure for the electric field calculation.
- Procedure for drawing the equipotential lines map.
- Program for determining the particle trajectory.

These four units are managed by a program that creates a friendly graphic-iterative environment for the development of the student work. These units are described with more details in the following lines:

Graphics editor: it is a program able to produce plane closed figures as rectangles, circles and triangles, for the design of the electrodes configuration. The figure choice is made through icons that appear in the screen close to the cursor. The cursor movement, as well as the figure dimensioning, is made with the use of the arrow keys. As the design is being completed, the program generates automatically the necessary grid, producing, when the design is finished, the data structure necessary to the electric field calculation. The potential values for the electrodes can be given at any moment. The editor has the necessary limitation of only generating figures with at least two dimensions. This is to avoid the mistake of drawing a line or a point that would not have physical consistency.

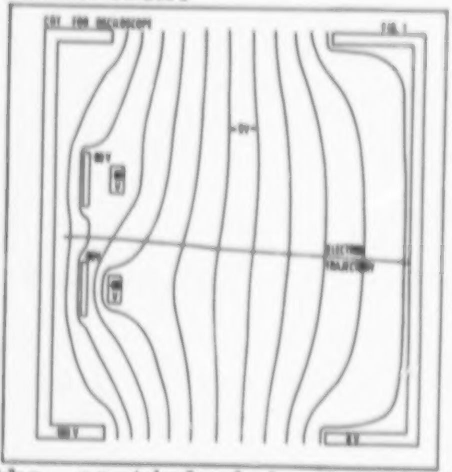
Mathematics procedure: never abandoning the graphics-iteractive environment, the student can ask for the electric field calculation, when consider his design ready. The calculation is performed until the pre-defined precision specified in the initial program configuration.

Drawing of the equipotential lines: if the student wants to "see" the electric field configuration, he can ask for the drawing of a determined number of equipotential lines. This map can also be plotted in the three-dimension form, V(x,y) versus x and y , making possible gravitational analogy.

Calculation and drawing of the particle trajectory: using the cursor movement over the work area, the particle position and initial velocity can be determined . The particle trajectory, starting in that point is immediately calculated and plotted over the area, with or without the equipotential lines.During each step in the program,data files are created and can be edited for ditatic purposes.

EDUCATIONAL PURPOSES AND USE METHODOLOGY.

The scope of this system is allow to the student the access to a experimenting environment, where can be built, together with a theoretical development, concepts related to electrostatic fields and their action over charged particles. It is possible, in a higher level, to aproach a expanded structure where the students would be able to develop device project techniques using the above described computer simulation.



A considerable effort was invested making the software able of modeling a large number of devices, as for example a simple capacitor or a simplified cathode ray tube (CRT - fig 1). This was made with two main objectives First to provide the teacher with the possibility of elaborate initial exercises, as for example providing the student with pre-calculated fields where he could experiment particle trajectories that could be interesting to a specific device and that would motivate the student to explain the particle behaviour. In second place this very flexible system would permit a more mature student to use it in designing and analysing his own devices.

CONCLUSIONS.

This system is being developed as a tool with the purpose that high-school and colege students could build, watch and modify simulations of electrostatic fields and charged particle trajectories in these fields. This program is also a temptative for the making of a standard software for simulations in physics problems that would be part of a wider learning environment, both by its project caracteristics or by its potential as a complement for a experimental physics laboratory.

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EDUCATION IN MICROELECTRONICS: ISSUES OF SAFETY AND PRACTICES

M. N. Kozicki[1] and P. J. Robinson[2]

ABSTRACT

The requirement for extentions to university curricula in microelectronics is discussed. The need for these additions arises due to the sensitive and hazardous nature of fabrication processes. The content of video supported undergraduate courses and industry short courses is outlined.

INTRODUCTION

The impact of microelectronics has become evident in a number of areas in modern society: communications, control systems, education, and leisure to name but a few. The field covers a broad spectrum of scientific subject areas, including electrical and chemical engineering, materials science, physics, chemistry, and computer science. Universities attempt to supply sufficient numbers of engineers and scientists worthy of this vital technology sector by providing various level courses in these disciplines. The sheer mass of information ensures that critical elements will inevitably be omitted. Engineers and applied scientists in microelectronics must work in, or deal with, highly controlled production or research environments such as cleanrooms. These cleanrooms demand complex operational practices for two reasons: 1.) contamination from the outside world, equipment and personnel can severely affect the working of the components, 2.) the materials and processes used are frequently extremely hazardous. Few universities are able to provide a "practice" cleanroom for students, forcing employers to provide such a learning environment. Many companies attempt to prepare their workforce through induction training, but generally cannot provide the depth necessary to give a comprehensive understanding of the work environment and how this knowledge can be effectively used. In this paper we discuss how this problem has been tackled at Arizona State University by use of undergraduate engineering courses and industry short courses.

PROBLEMS OF PROFIT

Modern accredited courses in electrical engineering (accredited in the US by the Accreditation Board for Engineering and Technology, ABET) have significant design components. Teaching the art of design has become a critical issue since design is linked to actual production and non-technical issues such as profit, corporate survival, domestic market share, and US dominance in global markets.

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The teaching of design may go so far as to introduce "real world" constraints: limited raw materials, standardization, etc. However, the tendency is to stop at the component's performance design, rather than also exploring problems in the physical manufacture of the component. This is a serious gap in the curriculum.

A marketable integrated circuit, manufactured through a particular fabrication technology, must have the capability of large quantity production at competitive cost. The yield, (the proportion of circuits which "survive" the fabrication process) and reliability of the circuits must also be high. Poor component design directly relates to both low yield and low reliability. A greater risk to yield and reliability lies in potential contamination, unwanted impurities such as microscopic particles or highly dispersed vapors, in the manufacturing process. The nature of microelectronic production (contamination sensitive materials, elements less than one millionth of a meter in size and multiple step processes used to fabricate the finished circuit) leaves much room for contact with failure producing contaminants.

The case for adding microcontamination and environmental (cleanroom) design to the traditional solid state curriculum is a strong one. The relation of component design to the marketed circuit and corporate profitability, clearly demonstrates this need. Additionally, the microcontamination experience adds value to the microelectronics degree. Indeed, education must go further and include training for engineers already engaged in microelectronics.

PROBLEMS OF SAFETY

The other, more sinister aspect of microelectronic manufacturing, not taught to any great degree, is safety. Admittedly, integrated circuit manufacturing is not publicly recognized as dangerous, certainly not when compared to the nuclear industry or the meat packing trade! This is due to our good fortune in disaster avoidance and low loss of life within the industry. As a result, the public may be lulled into a false sense of security. The microelectronics industry does have the capacity to cause harm to both its workforce and the local community.

One problem related to the manufacture of integrated circuits is the extreme hazard of many production materials. For example, a typical semiconductor plant will use many hundreds or even thousands of gallons of a diversity of chemicals in any given month. From a safety and toxicological point of view, the most dangerous production materials are the gases, arsine and phosphine. These materials are amongst the most toxic in any industrial process and, since they are in gaseous form, are much more difficult to handle and control than solids and liquids. To further illustrate: if a typical compressed gas cylinder (200 cubic feet) of arsine gas was released into the environment 800,000 cubic feet lethal volume would be created. Similarly, a tiny leak of the same material could create a very dangerous situation for the workforce; the legal safety limit is 50 parts of arsine per 1,000,000,000 parts of air.

Microelectronic engineers, especially those directly involved in designing the processes and equipment, must be aware of these dangers and know how to handle them (in the design stage and in the event of a "situation"), not only for their own sake, but also to protect a less knowledgeable workforce and innocent bystanders of the local community. As the industry grows in size and complexity, the need for increased safety education is imperative.

TRAINING AT THE UNDERGRADUATE LEVEL

Such extensions to the microelectronics curriculum are implemented at Arizona State University. Training at the undergraduate level (senior) is realized in a one semester, three credit hour course, Semiconductor Facilities and Cleanroom Practices (EEE 439), presented within the Department of Electrical and Computer Engineering. The course content includes: component yield and reliability, microcontamination, cleanroom concepts, cleanroom apparel, site selection, safety codes, ultrapure water, chemical handling and safety, waste treatment, process equipment safety, industrial hygiene, basic toxicology, medical and engineering controls, safety equipment and organization, emergency response, personnel training, hazard communication and legislation. The assessment is by short homework assignments, a midterm report and a comprehensive final examination. Topics are covered in lectures, demonstrations and discussions. A critical factor which makes this course so successful (as measured by student and industry response) is support from industry. Representatives from the semiconductor industry and support organizations (local and national) become actively involved, presenting lectures in their own areas of expertise. This helps to ensure that material is current and of relevance to the companies who will eventually employ the students after graduation. In addition, many companies, especially industry vendors, are only too willing to supply information and demonstration materials, including video tapes and "cutaway" models which enhance the course.

Unfortunately, the popularity of this course has created one problem: class size (typically 50) is prohibitive of facility tours. The very problems we attempt to bring to light, contamination and safety, can be caused by a large tour group in the clean facility. Tours are necessarily being replaced with video segments. Normally, course specific video material, professionally produced, would prove too expensive for most budgets, especially if the materials were continuously updated to include the most recent developments in the field. Fortunately, income gained from presenting industry short courses has purchased low cost video recording, editing and playback equipment.

A hand-held 8 mm camcorder ($1300 with accessories) is used to record the material, typically cleanroom interiors, support facilities and equipment shots. The camera work and voice overs are performed by the course instructor (voice overs may be performed using a clip microphone during shooting or dubbed in during editing). The small size, weight and performance in various lighting conditions, makes this equipment ideal for these purposes. Editing is performed using the camcorder, a standard 4-head VHS recorder and a low cost video effects switching system ($100). Playback in class is via permanent or portable monitors, placed to allow optimal student viewing. Our particular camcorder model allows superimposition of text and graphics on the picture. This helps to make the overall video production more "professional" in appearance. It should be noted that domestic-type camcorders do not have the resolution and time-base stability to produce broadcast quality footage, but are more than adequate for in-class presentation.

PROFESSIONAL OR POST EXPERIENCE TRAINING

The undergraduate course also attracts graduate students, primarily from the solid-state masters level programs. To ensure that the entire engineering community remains adequately trained, the courses must be taken off campus to reach the working engineer. At Arizona State University, we offer several alternatives.

The undergraduate Facilities and Practices course may be transmitted to fixed reception sites in local industries via the Interactive Instructional Television Programming (IITP) system. Many solid-state courses are already offered through this medium. The industry sites (Motorola and Intel are two examples) pick up the transmission of the live lecture and display it to employees enrolled in the class at the remote site. These corporate students are able to ask questions over the telephone during lectures. So far, this particular course has not been presented through the IITP system, although plans are being developed.

In most cases, working engineers wanting to expand their training prefer a short course offering rather than a semester-long course. To meet this need, Arizona State University presents a three day short course, which effectively condenses topics presented in the semester course. The presenters of the short course include the undergraduate course instructor, a senior industrialist, and an internationally recognized authority in microcontamination. To provide maximum flexibility, the course is presented as a public offering in different locations or as an in-house program. Over the past two and half years, the offerings of this short course have meet the needs of approximately 400 representatives of more than 75 companies.

A final medium in development is the packaging of this course in single topic video segments, marketed and distributed nationally and internationally. Additionally, a program of live and taped segments will soon be transmitted over a KU Band uplink from the University for reception at a network of national sites.

CONCLUSION

Education and teaching methods need to keep current with the mercurial nature of technology. We need to expose students to a wider curriculum in microelectronics. More importantly, we need to teach them and those out in the field the implications of their involvement in technology. The academic world and high-technology industry must forge new alliances to transfer knowledge, on a continuing basis, in both directions.

ACKNOWLEDGEMENT

The authors would like to thank Susan Alexander of the Center for Professional Development, for her help in writing this paper.

THE USE OF SPICE FOR ELECTRICAL MACHINE AND POWER SYSTEM MODELLING

L. Haydock*

ABSTRACT

A modelling methodology has been developed which produces realistic models of electrical machines, where each component is identifiable in the machine construction. The interactive linked distributed magnetic and electric equivalent circuit models have been applied to a range of very different machine types and sizes, from synchronous generators of over 500MW to machines of novel design such as flux-switching reluctance generators of below 50W rating and static devices such as transformers and reactors. The models can contain explicit motion and non linear (magnetic saturation) effects. The combination of these reduced order models and the power of SPICE has led to great computational efficiency. Typically, a flux decay (stator decrement) test requires only a few seconds of CPU time. A finite element simulation of comparable accuracy required several hours of CPU time.

This research led to the use of SPICE for teaching power systems and machines as well as its originally intended use in electronics. An example of a power system design exercise is given.

INTRODUCTION

The simulation program with Integrated Circuit Emphasis (SPICE) suite of programs was originated by Nagel (ref 1) in the mid 1970's for the simulation of large scale integrated electronic circuits, where breadboarding was no longer a realistic means of simulating new circuit designs. Following further development by many others, including Cohen (ref 2) and Liu (ref 3), SPICE has become an industry standard solver for the electronics industry worldwide. It is powerful and in most versions is "user friendly".

In the late 1970's the author researched and developed a modelling methodology for the production of linked distributed magnetic and electrical equivalent circuit models for transient and dynamic stability studies in power systems. The work was sponsored by the CEGB headquarters, London and the Science and Engineering Research Council, UK and was done initially at Imperial College, London, UK and later at Trent Polytechnic, Nottingham, UK. It was required that the models should stand between the over-simplified "generalised theory" or "two-axis" equivalent circuit models favoured by power systems analysts, but which had been found inadequate for modern power system studies by Shackshaft (ref 4), Canay (ref 5) and others, and the detailed finite element models used by machine designers, which may be accurate for design purposes but are too large and computationally expensive for use in power system studies.

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The modelling methodology established fulfilled these requirements (refs 6,7,8,9,10,11,12) and produced models which may include explicit motion of rotors, non-linearities such as magnetic saturation and interaction between the electric and magnetic circuits in the machine. The modelling methodology is general and may be used to absorb and correct past models such as those of Shackshaft (ref 4), Canay (ref 5) and Jackson and Winchester (ref 13), which can be shown to be special cases of the more complete "benchmark models" proposed by Haydock (ref 8). Care was taken to ensure that the models produced have components which are directly traceable to their origins in the actual machine construction, by making the modelling methodology a physical process as apposed to an abstract mathematical process. This has the advantage that the models are understood by "average" power system engineers. The methodology can be taught in only a few hours. Available space precludes a full exposition of the modelling methodology which is detailed in ref 8, but a few examples and results are given below.

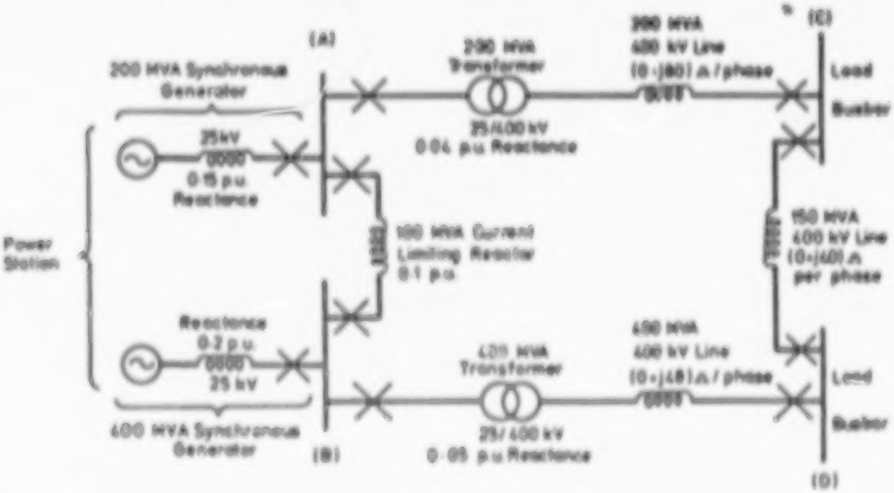
(A)
200 MVA Synchronous Generator
25kV
0·15 p.u. Reactance
200 MVA Transformer
25/400 kV
0·04 p.u Reactance
200 MVA
400 kV Line
(0+j80) Ω/phase
(C)
Load
Busbar
Power Station
100 MVA Current Limiting Reactor 0·1 p.u
150 MVA
400 kV Line
(0+j40) Ω per phase
Reactance
0·2 p.u
25 kV
400 MVA Transformer
25/400 kV
0·05 p.u Reactance
400 MVA
400 kV Line
(0+j48) Ω/phase
Load
Busbar
400 MVA Synchronous Generator
(B)
(D)

Fig.1 Power System Line Diagram

TEACHING WITH SPICE

SPICE is used throughout the undergraduate BEng degree course in Electrical & Electronic Engineering at Trent Polytechnic, Nottingham. Its use for electronics is widespread since it was introduced by the author in 1981 and until recently it has been used intensively for final year "Computer Case Studies" which were a compulsory course component before the course was revised in 1987. In future, it will be used more intensively in earlier years of the course and the trend seems to be to move away from the original mainframe versions towards workstation based systems with schematic capture and powerful post processing facilities for use in "VLSI" studies.

For use in power systems and machines teaching, an example is illustrated in Figure 1. This forms part of second year design study and laboratory investigation. One purpose of the study is to calculate circuit breaker ratings, bus bar voltages and line currents for worst-case 3 phase to earth symmetrical fault conditions for each of the bus bars A, B, C and D of Figure 1 in turn. The students are expected to employ the usual assumptions and make "hand calculations" for one case. They then run their own SPICE simulations, as given in Appendix 1, for each fault.

These tasks preceed their laboratory task, which is to make an analogue simulator and take results from it for comparison with the above two methods. The whole exercise usually produces sufficiently accurate and appropriate results for the purpose and stimulates interest in "power subjects".

RESEARCH (AND TEACHING) WITH SPICE

The essence of the modelling methodology is that magnetic permeances (Λ) are described as "Magnetic Capacitors" (C_m) following a suggestion by C J Carpenter (ref 14). This forces the following definitions:

Magnetic Permeance (capacitance) $\Lambda = C_m \triangleq \mu_o \mu_r \frac{a}{l}$ (1a)

(CF electric capacitance) $C = \varepsilon_o \varepsilon_r \frac{a}{l}$ (1b)

Magnetic potential (voltage) $V_m = F \triangleq iN$ (2)
(CF electrical voltage)

Magnetic flow quantity (current) $i_m = d\frac{\phi}{dt}$ (3a)

(CF electric current $i = d\frac{Q}{dt}$) (3b)

This has profound consequences and to some extent unifies further the electric and magnetic field theories. The magnetic equivalent of Gauss' Theorem follows immediately, since magnetic flux (ϕ) is analogous to electric flux (ψ) or the charge enclosed (Q). A further advantage over previous methods is that now magnetic permeances in iron etc can be non-linear and energy storage in the magnetic field in permenaces is correctly represented, whereas previous "resistive-permeance" analogies were energy dissipative. Therefore, transient conditions are easily dealt with, in addition to magnetostatic conditions. All normal "electrical" network theory is valid in magnetic (or electric or linked) terms.

With the addition of the "linkage theory" and the "half-transformer principle" and "tearing-principle" (refs 6,7,8) a simple reactor, used to limit fault currents in coal mines, was modelled by undergraduate students (ref 11).

Figure 2 shows the (simplified) topology of the reactor and Figure 3 the resulting topological linked electric and lumped magnetic equivalent circuit. The electricl source (V_{IN}) and source impedance (R_S) are linked to the magnetic circuit by a "Linkage Gyrator" Element, which is interactive both ways. The dummy voltage source VMEASIE measures the electric current (i) multiplies by the linkage (N) and injects the magnetic voltage F = iN into the magnetic circuit, as it should from equation (2). The magnetic current $i_m = \frac{d\phi}{dt}$, from equation (3a), is sensed by VMEASIM, multiplied by N and injected into the electric circuit as an "electromotive force"

$$e = N\frac{d\phi}{dt} \tag{4}$$

as it should. Therefore in the electric circuit the potential around the loop is

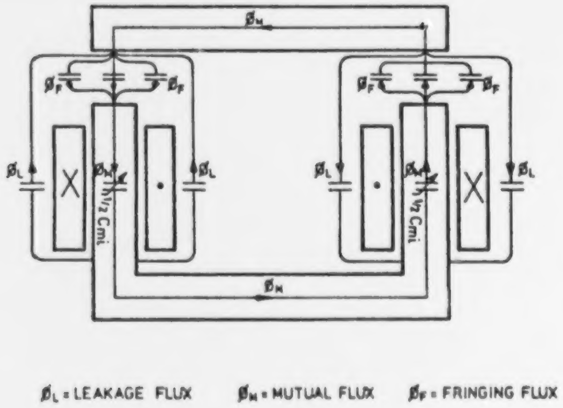
ØM
ØF
ØL
ØM
½ Cmi
ØL = LEAKAGE FLUX
ØM = MUTUAL FLUX
ØF = FRINGING FLUX

Fig. 2. Reactor Assumed Fluxpaths

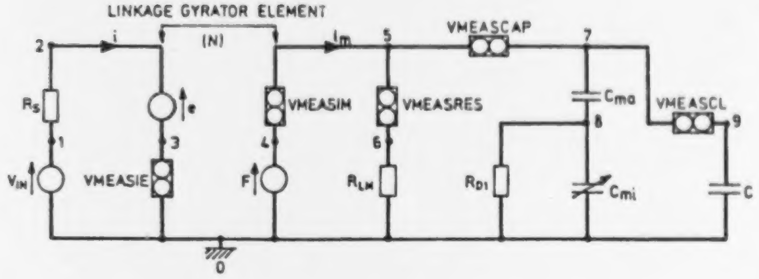
LINKAGE GYRATOR ELEMENT
(N)
i
Im
e
F
RS
VIN
VMEASIE
VMEASIM
VMEASRES
VMEASCAP
VMEASCL
RLM
RD1
Cma
Cmi
C
0
1
2
3
4
5
6
7
8
9

Fig. 3 Linked Electric and Magnetic Circuit

$$V_{IN} = i.R_s + e = i.R_s + N\frac{d\phi}{dt} \qquad (5)$$

This interaction is essential and may be extended to represent complicated windings such as machine phase windings. This work has been extended, in co-operation, by M J Carpenter (ref 15) to include large synchronous motor windings and power-electronic controllers in the same circuit and by Haydock and Sutton (ref 10) for full winding representation and explicit (saturated) rotor motion for a novel flux-switching reluctance generator, to produce instantaneous current and voltage waveforms on and off-load.

In Figure 3, the magnetic capacitors (permeances) C_{ma}, C and C_{mi} represent the airgap fringing, leakage and iron of the magnetic circuit, respectively. The latter is non-linear and is described by a polynomial fit to a curve derived from the material (steel) characteristics, so that magnetic saturation effects are modelled well over virtually the whole useful working range (ref 11). R_{LM} in Figure 3 represents the damping effect of the resistance of the electric coil on changes of flux in the magnetic circuit. This effect and its "referral to the magnetic circuit" has been coined "Dampance" by Haydock and is dealt with in detail in ref 8.

The solution of Figure 3 by SPICE is convenient since SPICE contains non-linear capacitors and current-controlled voltage source models. It has been tested against an actual laboratory transient test by feeding the reactor with dc at saturated levels and short-circuiting the supply. The fit to the resulting transient of current against time is virtually perfect for the simple model of Figure 3 containing interaction, magnetic saturation, leakage and fringing. The inductance is not constant and varies with saturation. By contrast conventional models ignoring the above effects produce a single value of inductance 100% in error (too low) and the fit is ludicrously innacurate throughout most of the transient (ref 11).

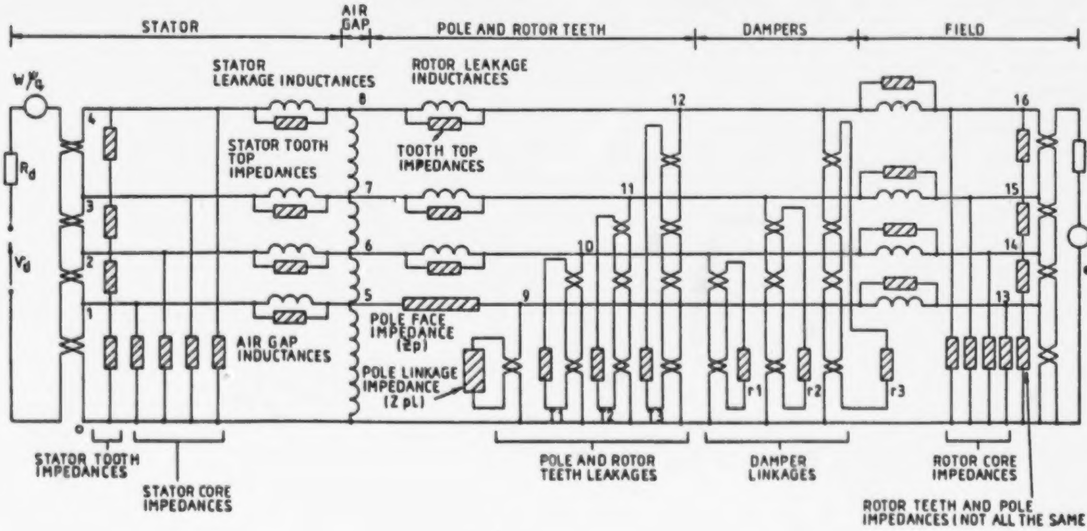
STATOR
AIR GAP
POLE AND ROTOR TEETH
DAMPERS
FIELD
STATOR LEAKAGE INDUCTANCES
ROTOR LEAKAGE INDUCTANCES
Wψ_q
R_d
V_d
STATOR TOOTH TOP IMPEDANCES
TOOTH TOP IMPEDANCES
AIR GAP INDUCTANCES
POLE FACE IMPEDANCE (Zp)
POLE LINKAGE IMPEDANCE (Z pL)
R_f
e_f
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
r1
r2
r3
T1
T2
T3
STATOR TOOTH IMPEDANCES
STATOR CORE IMPEDANCES
POLE AND ROTOR TEETH LEAKAGES
DAMPER LINKAGES
ROTOR CORE IMPEDANCES
ROTOR TEETH AND POLE IMPEDANCES (NOT ALL THE SAME)

FIG 4 DIRECT-AXIS "BENCHMARK" EQUIVALENT CIRCUIT INCLUDING IRON EFFECTS

RESEARCH

Figure 4 shows a proposed "benchmark model" for the direct axis of a large (660MW) synchronous turbogenerator with a solid iron rotor and stainless steel dampers. It can be derived simply in logical steps using a process similar to that outlined above for the simple reactor, except that the magnetic dual has been taken for the magnetic circuit only. Again all components relate directly to parts of the machine construction. The shaded boxes represent iron portions and may be non-linear. The quadrature axis circuit is even simpler and is derived by similar methods (ref 8). It is felt that the rigorous development of these circuits could make them either complementary to, or a replacement for the model of Jackson and Winchester (ref 13) in which the 1:1 correspondence between machine components and equivalent circuit components is, perhaps, not quite so clear.

RESULTS

Figure 5 shows the results of a flux decay (stator decrement) test simulation using a reduced order model derived in a similar manner to Figure 4 above, but solved at the magnetic equivalent-circuit stage, using SPICE. The CEGB actual test results are given for comparison and so are the results of a finite-element simulation by Turner (ref 16). The distributed magnetic and linked electric circuit model produces a marginally better fit than the finite element simulations. The equivalent circuit model required 6 seconds of CPU time on a small (DEC 20) computer. The finite element method required over six hours CPU time on a much more powerful computer. However, the methods can be complementary. Finite element methods can economically establish steady-state flux patterns to assist the disposition of equivalent circuit components. Equivalent circut models can then solve transients economically. This, combined with an improved method of analysis of flux decay test results proposed by Haydock (ref 8) can yield many more parameters than other tests such as sudden short-circuit or frequency response tests, for power systems studies.

CONCLUSIONS

SPICE is a useful tool in the teaching and research of electrical machines and when combined with the modelling methodology outlined can lead to very efficient models of electrical machines of various types, yielding parameters for power system studies.

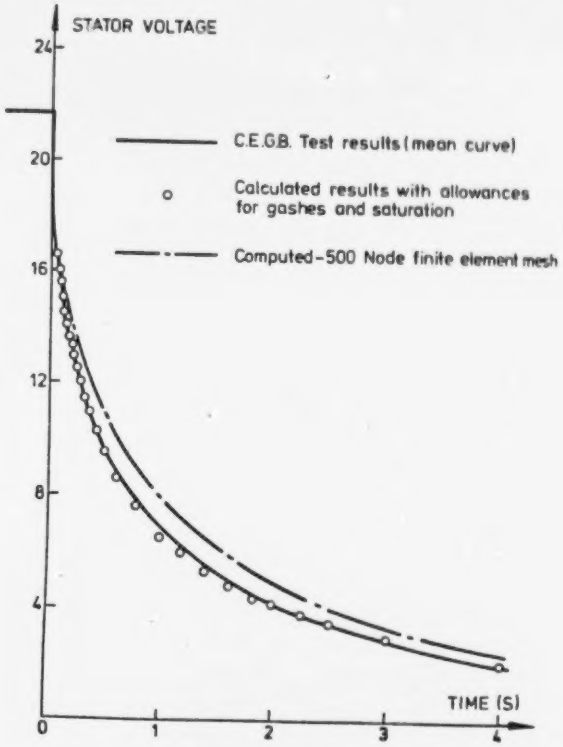

FIG 5 500MW GENERATOR FLUX DECAY TEST RESULTS

APPENDIX 1

The SPICE listing for the power system of Figure 1, using the usual assumptions, for a fault on bus bar D, including the output voltages at all bus bars, fault current and power dissipation, all in per-unit is given below.

```
FAULT1
*POWER SYSTEM FAULT ANALYSIS PROGRAM
*OUTPUTS ARE PER UNIT:-
*NODE/NODE VOLTAGE
*FAULT CURRENT
*FAULT LEVEL
R1 1 2 .3
R2 1 3 .2
R3 2 3 .4
R4 2 4 .28
R5 3 0 .17
R6 4 0 .1
VCC 1 0 DC 1
.OP
.END
NODE VOLTAGE NODE VOLTAGE NODE VOLTAGE NODE
(1)    1.0   (2)  0.5336  (3)  0.4733  (4)

VOLTAGE
0.1404

VOLTAGE SOURCE CURRENTS
NAME   CURRENT
VCC    -4.188D+00

TOTAL POWER DISSIPATION 4.19D+00
JOB CONCLUDED
TOTAL JOB TIME 0.65
```

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ELECTRICAL MACHINE SIMULATORS FOR TEACHING PURPOSES

J.R. Smith

ABSTRACT

Many modern electrical machine syllabuses include a series of lectures devoted to the dynamic operation of machine drive systems: in addition to the more traditional aspects of the subject, such as basic machine design and the derivation of steady-state operation characteristics. One of the recurring problems, associated with the teaching of this increasingly important facet of the subject, concerns the difficulty that arises in providing students with nontrivial problems and working examples. The practical system may be discussed and theformulation of the system equations derived in the classroom, together with a possible solution strategy based on traditional numerical techniques. However, a demonstration of system response is usually reserved for a practical laboratory exercise. User friendly fully representative electrical machine programs, used in the reponse of complicated drive system and provide the means of transgressing the gulf between the theoretical considerations that are necessary for installing a firm group of the electromagnetic and electromechanical principles of the mechanism to a demonstration of the various problems to which the analysis may be directed. It is not suggested that such an approach should supplant laboratory-based 'hands-on' experience, but serve to enhance a student's appreciation of the subject as it is taught. The paper will describe how such programs are used in the teaching environment in the U.K. and Middle East.

Aberdeen University

AN IBM PC COMPATIBLE COMPUTER ASSISTED LEARNING PACKAGE ON THE PERFORMANCE OF THREE-PHASE INDUCTION MOTORS (CALIM)

W.M. Hosny *

ABSTRACT

A computer assisted learning package (CALIM) is under development at NELP on the Amstrad 1512 pc computer which enables the steady-state performance of conventional types of induction motors to be simulated. These comprise the squirrel cage rotor, double squirrel cage rotor and wound rotor induction motors. CALIM is aimed at users who are familiar with the general construction and fundamental theory of induction motors and wish to investigate their steady-state behaviour without resort to repetitive, laborious and time-consuming measurements in the laboratory. In developing CALIM, care has been taken to emphasise the influence of variations in the motor's parameters on their characteristics. This profoundly enchances the learning process regarding the behaviour of these machines.

INTRODUCTION

Recent statistics carried out by (ref.1) one of the leading electrical research establishments in the U.K showed that the most common electrical machine used in industry today is the a.c. 3-phase induction motor. This is therefore an essential ingredient in a syllabus including electrical machinery. Teaching the elements of the induction motors to a newcomer over a limited time has always been a difficult task. Not only a good foundation in the basic theory is needed, but also a practical grasp through laboratory experiments. The CALIM package aids in this process by presenting the student with data such as would be obtained from such experiments, avoiding much of the laborious and time-consuming measurements in the laboratory. Of course, hands-on experience cannot be entirely replaced by digital simulation and CALIM is intended to enable the student to use his time more effectively in practical sessions. This is a valuable development in view of the ever increasing demands placed upon students of electrical engineering in terms of syllabus content.

CALIM is an interactive package and also facilitates self-learning of the theoretical aspects of induction motors. A high level of user friendliness is attained by use of a hierarchical menu structure.

It is planned to integrate CALIM into the second and final years of the B.Eng degree syllabus in electrical and electronic engineering at NELP.

Attention is restricted to steady-state performance at present. Further development of the package to include transient performance is planned.

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SCOPE OF CALIM

Equations that describe the steady-state performance of induction motors have been programmed in Fortran 77 on the Amstrad 1512 pc computer. Induction motors are usually classified according to their rotor construction and fall into three categories:-

i) wound rotor induction motor (WRIM)
ii) squirrel cage (or single cage) induction motor (SCIM)
iii) double cage inducton motor (DCIM)

For the first, the rotor resistance may be varied by means of external resistances as shown in Fig.1. For the second and third, the rotor resistance has a fixed value according to the cage construction as shown in Figs. 2 and 3.

The following assumptions are made in the machine models:-

1. Per-phase electrical equivalent circuits are adequate for performance prediction

2. Variation of equivalent circuit parameters with environmental conditions, such as temperature and humidity, is negligible.

3. A 3-phase sinusoidally-time varying balanced supply is utilised.

THE CHARACTERISTICS AND THEIR DISPLAY

CALIM embodies equations describing the steady-state behaviour of induction motors in terms of their equivalent circuit parameters (ref.2). The following performance characteristics may be displayed on command:-

i) torque versus slip
ii) efficiency versus output power
iii) power factor versus output power

All the data required for graphical display is stored on disc. The Meta WINDOW graphics package, renouned for its high performance and speed (ref.3), is utilised for display of the selected characteristic.

THE INTERACTIVE STRUCTURE OF CALIM

On loading the program, the main menu appears on the user's terminal, as shown in Table 1.

Table 1 Main Menu

```
 ________________________________
|      AC  Motors                |
|1. Three-phase induction motors |
|2. Three-phase synchronous motors|
|3. Two-phase induction motors   |
|4. Single-phase induction motors|
|5. AC series motors             |
|6. Switched reluctance motors   |
|7. Quit                         |
|________________________________|
```

On selecting 3-phase induction motors, for example, a submenu appears, listing types according to the rotor as shown in Table 2. The user may return to the main menu or quit if he so desires.

Table 2 Induction Motor Types

```
 ___________________________________________
|   Three Phase Induction Motors            |
|                                           |
|1. Wound rotor induction motors            |
|2. Normal squirrel cage induction motors   |
|3. Double squirrel cage induction motors   |
|4. Return to main menu                     |
|5. Quit                                    |
|___________________________________________|
```

Upon selection of options 1, 2 or 3, another submenu appears on the monitor screen listing the various characteristics that may be displayed. For option 1, this submenu appears as in Table 3.

Table 3 Graphical Display

```
 ____________________________________________
|   Wound Rotor Induction Motors             |
|                                            |
|1. Motor parameters                         |
|2. Motor torque-slip characteristic         |
|3. Motor efficiency versus output power     |
|4. Motor power factor versus output power   |
|5. Return to three-phase motor menu         |
|6. Quit                                     |
|____________________________________________|
```

Selection from options 1 to 4 then leads to a displayed characteristic utilising default motor parameters. The user may then modify these parameters if he wishes. Moreover, the user can create his own data file. A hard copy of the screen display can be dumped to the printer on command.

EXAMPLES OF CHARACTERISTIC PLOTS

In Figs. 4 and 5, examples of torque - slip characteristics, for single and double cage induction motors are shown. These show clearly that the double cage motor has better starting performance than its single cage counter part. This is due to the presence of the upper cage which is located in slots close to the air gap and is made of a high resistivity material. In Fig.5 the individual torque-slip characteristics for the upper and lower cages of the double cage motor are shown, together with the resultant characteristic.

Fig.6 shows a set of torque-slip characteristics for a wound rotor motor with different values of external rotor resistances. It is clear from this figure that the maximum torque developed by these motors is independent of the value of their rotor resistance. However, slips at which maximum torque is developed increase approximately in proportion to the rotor resistance.

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FURTHER WORK

The software for items 2 to 5 in Table 1 is to be developed shortly. First, however, it is intended to conduct field trials with the three-phase induction motor option and obtain feedback from students. This will ensure that CALIM ultimately fulfills the originally intended purpose of facilitating effective self learning together with enhanced and efficiently conducted laboratory sessions.

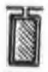

Fig.2 Cross-section in a slot in a single-cage rotor induction motor

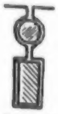

Fig.3 Cross-section in a slot in a double cage rotor induction motor

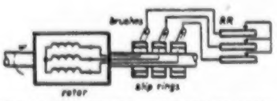

Fig.1 Resistances connected in series with wound rotor motor phase windings

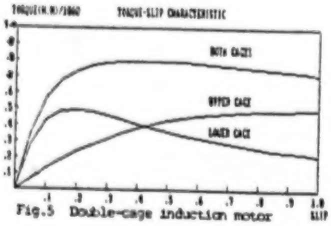

Fig.5 Double-cage induction motor

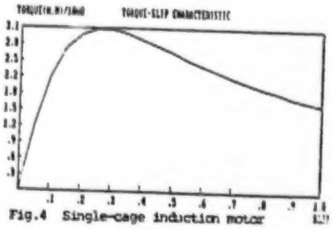

Fig.4 Single-cage induction motor

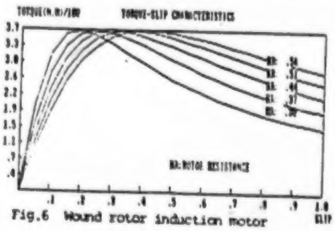

Fig.6 Wound rotor induction motor

AN OVERVIEW OF ARTIFICIAL INTELLIGENCE AND POWER SYSTEM PROTECTION

L.L.Lai.

ABSTRACT

This paper describes the survey which has been carried out to determine those aspects of power system protection to which the artificial intelligence (AI) can be successfully applied. These have been identified as those problems which are subject to a combinational explosion and those which can be handled by heuristic rules derived from experience.

INTRODUCTION

Recently, a survey on the applications of expert systems to power system protection has been carried out by the author. The finding has been reported in reference (1). This paper describes the survey which has been carried out to determine those aspects of power system protection to which the artificial intelligence (AI) can be successfully applied.

ARTIFICIAL INTELLIGENCE

Artificial intelligence is a theoretical research area in nature where one analyses human intelligence and tries to give the latter to the computer. The key things to the success of artificial intelligence approach are the absence of analytical technique and the availability of good experts. AI techniques are applied to theorem proving, natural language understanding, speech processing, perception and pattern recongnition and expert consulting systems.

Expert systems are a branch of artificial intelligence and allow computers to deal with the "fuzzy" type reasoning upon which many human decisions are based. The expert systems languages, or shells, are generally deficient in the ability to edit the knowledge base and to analyse the reasons why decisions have been made.

The two main AI languages are LISP and PROLOG, neither of which is particularly new, LISP (List Processing) has been available since the fifties and PROLOG (Programming in Logic) since the early seventies. The former originated in America, the latter in Europe.

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The requirements of future expert systems are an increase in the number of rules in the rule base and an increase in the number of data elements contained in the working memory. Also, many new applications require that expert systems move into real-time domains.

APPLICATION AREAS

In this section, five application areas of the AI technique in power system protection are listed.

(a) Switching of power systems

An approach by means of mathematical logic to the switching of power system networks was reported in reference (2). The approach points to the way in which constraints to be imposed on the operation of a power system may be represented by symbols and equations of the kind used in mathematical logic.

The basic principles of the application of logical switching techniques to the control of power systems has also been outlined in reference (3). The mathematical logic approach permits a fully quantitative basis for the design of complicated sequence switching networks. Provided that all the facts are available and the process by which the deductions are made is known, an expert system could be built to make the necessary decisions in the same way as the engineer.

(b) Relaying operations

It is difficult for the dispatchers to locate a fault section.

A logical procedure has been described in reference (4) that analyses a circuit breaker and protective relaying operations in a power system in order to derive an up-to-date picture of the power system network and to obtain a realistic diagnosis of system faults. These procedures are made up of logical variables and logic statements rather than mathematical operations.

More recently, an expert system (5) has been developed to help dispatchers to find the fault section if there are some false operations of relays and circuit breakers.

After estimating the fault section, the sequence of relay operations and tripping can be estimated using the basic rules of relaying schemes, and the inference system can explain why the faults occurred.

(c) 'Adaptive' protection

A new approach (6) is presented to the selective network protection in the framework of computer control of the power system in normal and emergency conditions.

By using digitised voltage and current transformer outputs as the sole physical input, the entire selective protection operation reduces to modest size software on existing station and control center computers without using any explicit protective devices or relays. This major simplification is accompanied by major increases in accuracy, speed and reliability. It is also inherently adaptive, that is, no online and offline coordination of protective devices is required. This approach results in an expert system designed with natural intelligence.

(d) Protection coordination

Analytical techniques require excessive computation and are often cumbersome to use. Present research is intended to combine analytical algorithms with the logic programming of rule-based systems in order to provide an interactive decision-support tool.

While design is basically a problem-solving activity, most of the progress made by the CAD systems during the past few years has been concentrated in man-machine communications and data-base management. Consequently, most current CAD systems lack problem-solving capabilities.

The concepts and techniques developed in AI can be applied to CAD systems software so as to free the designer to concentrate on stages of the design process in which decision has a greater impact on the final solution.

CAD methods can be applied in AI problems mainly in the problem definition phase, while AI methods in CAD mostly in heuristic search for accelerating the problem-solving process in very complex tasks.

An expert system has therefore been developed for recording and modelling knowledge of power engineering experts in the domain of protection coordination for industrial power systems (7). The system has been implemented using the POPLOG programming environment and was written in the POP-11 programming language.

(e) Diagnosis of generators

As turbine generators increased in size and complexity the difficulty of identifying potential problems increased.

An artifical intelligence based, online turbine generator diagnostic expert system is presently under development (8).

The expert system will link into the existing plant computer control system, take required information from it and fill up its knowledge base. A diagnosis will be performed on all the available sensor data, even though certain inputs to the rule base may not have been available.

By using the inputs from a number of sensors, the diagnostic system evaluates the condition of the equipment and communicates appropriate action.

CONCLUSIONS

Lessons learned from the experiences so far have been discussed from the standpoint of individual problem analysis. Some possible applications have been outlined and the importance of human interface issues have been emphasised.

Attitudes toward the new technology are positive but much effort is required before wide applications of AI to power system protection could be seen.

For applications requiring real time response from an expert system conventional implementations may not be practical. Parallel computer architectures are needed to overcome the performance bottleneck of sequential execution. However, the potential applications of the very scale hardware parallelism to the execution of AI systems has remained largely unexplored.

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COMPUTER TELECOMMUNICATIONS FOR THE CLASSROOM: A SUMMARY OF ACTIVITIES

Richard E. Riedl

ABSTRACT

There are a number of active and proposed projects and networks that use computer communications to link students and classrooms around the world. This is a summary of some projects and networks, their goals and their procedures. Among active projects summarized are Computer Pals Across the World, the InterCultural Learning Network, FrEdMail, and KidNet. Systems included in the summary are the McGraw-Hill Information Exchange and AT&T's Long Distance Learning Network.

INTRODUCTION

> The new forms of teaching and learning made possible by electronic communication poses [sic] exciting challenges. For the educational community it offers the key to escape from the physical isolation of classrooms. Group interaction across distances facilitated by computer telecommunications is qualitatively different than that provided by phone, memos, and postal mail and offers new strategies for teaching and learning. It is this potential--the ability to create and maintain group interaction among people dislocated in time and space--that attracts the technically skilled teachers of the 90's. (ref 4)

A number of computer communications projects and activities are currently underway, or proposed. It is important for any educator interested in using computer communications to learn from the successes and failures of these existing projects. While this paper will be too brief to attempt a full description of all the projects and activities now taking place, it is hoped that enough information can be presented to illustrate the richness of computer communications potentials.

COMPUTER PALS ACROSS THE WORLD

One of the largest projects involving pen pal activities is Computer Pals Across the World. It was started in 1984 as a small project to link isolated Alaskan schools with schools in Australia. It has grown into a worldwide project involving almost a thousand schools. Its main means of organization is to match a class from one site with a class from another site. The teachers from the matched classes then organize their activities to suit their situations. The major themes of Computer Pals activities are to improve written communication, provide opportunities for cultural exchange, and to familiarize students with telecommunications technology. Computer Pals has moved to a single electronic mail service and focuses its activities around writing on word processors and uploading and downloading messages with a minimum of time (and cost) on the service.

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While pen pal projects still make up a portion of the computer communications activities, there has been a significant evolution away from this concept toward more involved interactions. A pen pal project tends to focus on matching one class with another, and within that one student with another student. Most of the projects emerging over the last two years have tended to link classes from three or more sites. These groups at the different sites work on some agreed upon, common activity, the results of which are shared at various times during the length of the project.

INTERCULTURAL LEARNING NETWORK

One of the first groups to establish such a pattern was the members of the InterCultural Learning Network (ICLN). ICLN is a very flexible, loosely organized grouping of schools and teachers. Its main purpose has been to provide a vehicle with which to study the nature of telecommunications projects. One of their most successful projects was the Water Problem Solving Project. In this project classes from Israel, Mexico, Japan ,and the United States each researched the use of water in their own locale and reported their findings. The original organization of the project was carried out by the teachers via the electronic network but the actual research activities were conducted without the use of telecommunications. After the results were reported, using electronic mail, follow-up discussion between the classes was conducted on the electronic network. In this discussion the students from the different sites sought clarifications from the other classes on the information reported, looked for similarities and differences in the ways water is handled in the different locations, and sought solutions to common problems involving the use of water (ref 1).

FrEdMail

On the FrEdMail system there is likely to be a wide variety of activities and projects ranging from pen pal arrangements to problem solving projects like the one just described. FrEdMail is a system of bulletin board systems. It consists of about 80 electronic bulletin boards, each with a variable number of users. The individual bulletin boards have an inter-board capacity which allows users of the individual boards to participate in a distributed network. All but four of the boards are in the United States (there are two each in Puerto Rico and Argentina) and the majority of those boards are in California.

On FrEdMail there are two system-wide conferences open to all users. The IDEAS conference is where teachers suggest and organize possible projects, locate resources, and provide technical support for each other. The KIDWIRE conference is where teachers can post student work (ref 3). The types of activities on FrEdMail tend to vary a great deal and depend a great deal on suggestions made on the IDEA conference and negotiation between teachers interested in a common activity. Its original goal was to provide real audiences and real purposes for student writing. With its growth the role of providing a cost effective electronic communications network has emerged as the major, and successful, function of the system.

NATIONAL GEOGRAPHIC KID'S NETWORK

KidNet represents a somewhat different effort to utilize electronic communications. The National Science Foundation (U.S.) and the National Geographic Society (U.S.) have funded the Technical Education Research Centers in Cambridge, Massachusetts to develop curricular materials and telecommunications software for publication by the National Geographic Society. During the development period classes were organized into clusters of ten to twenty, each carrying out a prescribed set of research activities. Teachers in the clusters used an electronic network to work together on the implementation of the curricular materials and to share the results of the activities. Perhaps the key feature of the KidNet effort is the attempt to provide a set of prescribed materials and activities that are designed and tested for use by classes connected by an electronic network. Even more important is the effort to provide software that takes the focus of the activities away from the difficulties of using an electronic network and puts it on the content of the curricular materials. Like the successful ICLN activities, the main emphasis is on using the electronic network for initial planning and reporting and discussing results.

McGRAW-HILL INFORMATION EXCHANGE

The McGraw-Hill Information Exchange (MIX) is a commercially developed network designed for education with approximately 2,000 subscribers. It is centered around a computer conferencing system that provides more flexibility than the straight electronic mail systems that have been used by earlier projects. At any given time there are several conferences that are actively involved in a project. Each conference is supported by a moderator who organizes and conducts the project around which the conference is focused. There is a Student Information Exchange (STIX) conference in which student activities are suggested. Once sufficient interest and organization for a specific activity is accomplished the participants move into their own conference in order to proceed with the project. Successful project conferences average between 15-25 teacher participants (ref 4).

In order to keep the cost of using computer telecommunications under control, MIX has developed a fee structure that includes a one year membership in MIX and the purchase of blocks of time on a telecommunications network needed to access MIX. The intention is to put the cost of participation up front and to give the school a clear idea of the amount of time they will have on the system.

AT&T's LONG DISTANCE LEARNING NETWORK

The Long Distance Learning Network (LDLN) is a development project that may be developed into a commercial service. A good deal of its development has been based on the work of the InterCultural Learning Network. In a Spring, 1988 test of LDLN, teachers were assigned to learning circles based on their interest, grade level, and location. Each learning circle had a coordinator who helped the teachers develop projects with telecommunications components. The learning circle activities were of a finite duration and expected to produce a final product that could be distributed to other participants. Much of the work on the projects was off-line and focused on sharing results and interpretations of results.

LDLN used a toll free 800 number rather than an existing data communications number. The electronic mail on this service was divided into folders, each folder representing one learning circle. All mail sent to the folder was automatically distributed to all the members of the learning circle who shared that folder and was also stored online, chronologically, for future reference (ref 4).

CONCLUSION

It is apparent, even from this brief summary, that there is a great deal of rich activity taking place in educational telecommunications. Each of the activities and projects mentioned represents a slightly different approach to the use of computer communications in schools. It is hoped that those who wish to pursue the use of computer telecommunications in their school will seek to learn more about those activities that have served to break the ground.

Anybody wishing more information about the projects covered in this paper or who would like the names and addresses of contact persons for the projects, please feel free to contact the author.

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UCF INTERNATIONAL STUDIES PROGRAMS SATELLITE SYSTEMS

A.V. Cervone

ABSTRACT

1. The Office of International Studies of the University of Central Florida plans to have satellite hookups and retrieve television programs in Spanish, French, Italian, German, Russian and Japanese as well as other languages as they become available through the satellite relay. We will also set up monitors at strategic points on campus so that students of those languages and community members may view them.

2. A resource bank will be established containing films, slides and other programs of cultural nature that will be available to the school systems K-12 of the eleven counties which UCF serves.

3. A data bank of language instructors will be established drawing on the resources found in the community as well as the university so that a one-on-one instruction will be available in virtually every langauge of the world.

4. A data bank of interpreters will be available for the community and university to be at the disposal of police, courts and tourist industry.

5. A computerized connection between this campus and its study abroad program offices will be established in order to facilitate the transferral of financial, administrative and student records.

6. A satellite hookup system will be developed whereby our students will be able to confer with their counter parts on cultural, academic and linguistic matters on foreign campus'.

7. Radio and television programs currently available via satellite but through the auspices of the Italian, French, and German television stations will be broadcast on cable channels for viewers in the greater Orlando area.

8. Translation programs will be available to the faculty and the community in virtually every language as programs are developed. Currently research is taking place at Yale University and we are carefully monitoring their progress.

9. Similarly, the Boston Public television station has received a five million dollar grant to develop computerized instruction in foreign languages. We are eagerly following their progress so that such programs will be purchased and available on this campus.

10. A computerized foreign credentials evaluation system will be available to international students who apply for admission to this university.

University of Central Florida

ADULT ELECTRONIC TUTOR TO ENHANCE PERFORMANCE OF NON-TRADITIONAL ADULT LEARNERS IN THAILAND'S OPEN UNIVERSITY

George A.B. Moore*

ABSTRACT

Distance education differs from private study in that two-way communication is established between the teaching agent and the learner. Traditionally this has relied on correspondence techniques to bridge the gap separating teacher from student. In Thailand, Sukhothai Thammathirat Open University (STOU) was created in 1978 to meet the growing need for post secondary access among its adult population. Using a multimedia delivery system STOU is now exploring the use of a microcomputer based tutorial and testing system to improve student performance in courses with enrollments of up to 20,000 class members. Initial response from students indicates an acceptance rate of 95% among non-traditional adult learners attending a 5 day Professional Experience course prior to graduation.

INTRODUCTION

The growth of distance education in the past two decades and the new access possibilities opened up for adult learners has resulted in educational delivery on a scale unprecedented in the experience of most academics reared on traditional group-based instructional practices. Distance education is more than private study and requires communication between the instructional agent and the learner. With classes numbered in the thousands the traditional ratio of 1 teacher to 25-50 students is unworkable. In this paper an approach is described which uses a microcomputer based learning system to address aspects of teacher-learner communication in providing feedback to students studying in courses with enrollments of up to 20,000 students.

COMMUNICATION AND INTERACTION IN DISTANCE EDUCATION

Distance education is characterized by the quasi-permanent separation of the teacher from the learner for much of the learning process. To bridge this gap Keegan states that distance education relies on some form of technical media to provide two-way communication so that the student may benefit from or even initiate dialogue. (ref 1). He identifies two additional characteristics of distance education as the influence of an educational organization in the planning and provision of materials and student support and the quasi-permanent absence of a learning group. Students in distance education are thus usually taught as individuals and in a more private situation than is the case in conventional group based learning.

In this context establishing and maintaining communication is an essential element in distinguishing distance education from private study. Otto Peters (ref 2) in his comparative analysis of conventional teaching and

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distance education contends that these are diverse systems offering two different forms of instruction: "traditional face-to-face teaching based on interpersonal communication and industrialized teaching...based on an objectivised, rationalized, technologically-produced interaction." (ref 3) The Challenge facing distance educators is how to provide these artificial and mechanical substitutes for interpersonal communication in such a way as to minimize the propensity to alienation.

One of the attributes of distance education is the increase in freedom, autonomy and independence it affords the adult learner. Charles Wedemyer and Michael Moore emphasize this characteristic of distance education while Daniel suggests the more freedom the less likely the student is to complete the course. (ref 4) Drop-out rates of students in distance education are of recurring concern but based on the experience of the UK Open University this problem is solvable. A number of factors have contributed to this but the degree of communication between the teaching agency and the students would appear to be a primary consideration. The OUUK invests considerable resources in maintaining student contact through its network of regional offices, counsellors and tutorial staff. Can this achievement be replicated in newer institutions, especially in developing countries, where adequate numbers of qualified tutors may not be available? The task addressed in this paper is one such situation in Thailand's distance teaching university, Sukhothai Thammathirat Open University (STOU).

THAILAND'S OPEN UNIVERSITY

The concept of open university education was introduced to Thailand in 1971 with the creation of Ramkhamhaeng University, an open admission university operating with traditional, but optional, classroom activities. By 1978 its student population had passed 100,000 and a second campus was needed. As an alternative to building more conventional capacity STOU was given a Royal Charter in September 1978 to become the first distance teaching university in Thailand and Southeast Asia. In December, 1980 STOU enrolled 82,000 in two schools, Educational Studies and Management Science. By 1985 it had graduated 38,318 students (ref 5). Its student body is made up in large measure of working adults of whom 85 per cent live outside the capital city of Bangkok.

A multimedia instructional systems approach is used in the design and delivery of courses. While print materials are the core medium and account for 180 hours of study time per semester, the student will have between one and 15 60-minute audio tapes, 15 20-minute radio programs and five 30-minute television programs (ref 6). In addition an extensive network of regional (11) and local (66) study centres situated throughout the country enable tutorials to be held close to student homes. Tutorials are optional and offered in approximately 30 percent of the courses with an attendance by about 30 percent of the students (ref 7). All graduating students are required to attend a five day residential Professional Experience Course which is now held in a well equipped modern 400 bed Student Training Centre on the campus in suburban Bangkok. There are thus several mechanisms in place to facilitate and support communication and interaction between the university's academic staff and the student although the primary mode of communication is via the one-way print medium.

ELECTRONIC TUTOR PROJECT

As noted above the tutorial program has been implemented in approximately one-third of the courses. In some courses there are insufficient part-time tutorial staff available to service the tutorial program, especially courses in mathematics, science and statistics. Some of these course enrollments reach 20,000 students per year and failure rates are in the order of 80 percent. STOU has been concerned about this enormous wastage in human energy, effort and emotional health. In 1985 the Rector of STOU in association with an instructional design team from the University of Guelph embarked on a project to adapt and test a Canadian videotex development to the needs of distance education in Thailand by addressing these high failure rates.

Work at Guelph had concentrated on developing a microcomputer based instructional application of the TELIDON videotex system. TELIDON provided a high quality color graphic display and one which was easy to use by teachers and students not skilled in computer programming. The authoring system called VITAL was adapted to create and display instructional materials in the Thai language (ref 8). VITAL's instructional capabilities are described by Moore elsewhere (ref 9).

The project has incorporated the principles of Keller's Personalized System of Instruction (PSI) into the design of a series of mastery tests to accompany the existing modularized materials in three of the core courses in Science and Society, Mathematics and Social Science and Economics and Business Statistics. McKeachie in reviewing a number of instructional methods in use in universities includes PSI as one of those having "had more impact on college teaching in the 1970's than any other innovations" (ref 10). PSI courses are print based, use self-pacing by students, are mastery oriented, use frequent tests and provide immediate feedback. Research on PSI courses shows that content learning as measured by final examinations is good and that student performance is superior in courses following a PSI course. The feature of frequent testing and immediate feedback is identified by research as contributing to these educational gains (ref 11).

ACHIEVEMENTS

Since the distance teaching system of STOU already had adopted a modular approach and used print media as the core instructional vehicle the "electronic tutor" project added that missing but critical element of frequent testing with immediate feedback. Test packages have been produced by Thai academic and technical staff for each of the 15 modules in the three science and mathematics courses identified as the problem courses. Multiple choice type questions are used and a simplified response system is used in which 5 numeric keys have been color coded along with the return key. Students are instructed to make their responses using these six keys. A confirming feedback frame is displayed immediately following a correct response and a detailed feedback frame is presented with remedial study suggestions for each incorrect response. The test packages are accessed by students on an IBM ps 2 model 50 microcomputers located in each of three regional study centres in the pilot project.

Preliminary testing of the system with 71 students attending a (ref 12) Professional Experience Course revealed a high degree of student acceptance. Ninety-five percent favored the regular use of the "electronic tutor" in other courses while 85 percent reported it had helped them in understanding content they had already studied with the print materials. Sixty-nine percent of the students interviewed reported they found the VITAL "electronic tutor" as easy to use. Field testing of the materials is being conducted during February-Arpil, 1989, to assess this approach in enhancing academic performance of non-traditional adult learners enrolled in distance education.

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TRENDS IN MATHEMATICS TEACHING

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ABSTRACT

This paper discusses how the computer is influencing the teaching of mathematics in schools and universities. In particular we look at the advantages of using computer algebra in distance teaching for the benefit of the independent learner. The paper takes a critical look at currently available computer algebra packages and describes some work being done at the Open University to make these packages more pedagogically suitable. Finally we take a futuristic view of the use of computer algebra in all aspects of the educational process.

INTRODUCTION

There is a great deal of current interest in the way in which computer algebra (CA) systems are, and will, affect the teaching of mathematics in schools and universities. Here we look at the effect such systems will have on the independent learner. By the term *independent learner* we mean those students who study on their own, often at home, with little or no face-to-face tuition. The UK's Open University (OU) has been a pioneer in the field of distance education providing, amongst other things, full undergraduate and graduate programs designed specifically for the independent learner. In 1988, for example, the University catered for over 70,000 undergraduates, 1,300 postgraduate students and over 90,000 continuing education students taking a variety of non-degree courses. The independent learner approach is now being adopted in other, more conventional teaching establishments.

The OU has adopted a multi-media approach to teaching which includes texts designed specifically for distance education, television and video programmes, radio and audio cassettes, and computer assisted learning (CAL) software. CAL has been a part of the OU's teaching strategy from the beginning but has not reached its full potential primarily because it has been difficult to provide suitable computing facilities to a student population that is geographically widely dispersed. Solutions to this problem have ranged from slow hard-copy terminals based in selected towns and cities to terminals in the home communicating with central main frame computers via the public telephone system. Early attempts to provide computer packages for students did, however, enable the OU to develop a great deal of sophisticated teaching software and, in so doing, generated a lot of expertise in the production of CAL packages.

It has been obvious for some time that the microcomputer has much to offer the educational establishment. Effective CAL requires substantial computing resources and we have had to wait, therefore, until the unit cost of microcomputers became low enough *and* there was evidence of a substantial market penetration of micros in the home. This situation has now arrived: in 1988 the OU negotiated substantial discounts on microcomputers to enable the first courses to be included in its *Home Computing Policy*. We are now in a position to assume that all students have quick and easy access to computing resources, and therefore provide software as an integral part of course materials. CAL can now be incorporated into any programme as a fundamental teaching tool.

Progress in the use of CAL for mathematics has been less than spectacular. For example, we have concentrated on providing software packages in the more traditional areas of numerical analysis and mathematical modelling (providing numerical solutions to calculus problems). Computer graphics have also been used to advantage (usually for numerical purposes and, more interestingly, in the production of animations for TV and Video programmes). What is much more exciting, and has the potential to revolutionize the teaching of mathematics, is the availability of computer algebra packages on low cost microcomputers.

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By *computer algebra* we mean the ability to use a computer to manipulate expressions algebraically. Such expressions can include algebraic, differential, integral and matrix objects, and the manipulations are primarily those of substitution as opposed to numerical evaluation. That is, mathematical rules are used to rewrite an equation in such a way as to solve it. Traditionally, a distinction is often drawn between the analytical and the numerical solution to a problem; a computer algebra system provides the analytical solution where ever possible. Much mathematics teaching revolves around providing students with the skills required to manipulate expressions through the use of rules that describe the objects in a specific area of discourse. Computer algebra packages are set to have the same kind of impact on mathematics teaching that the hand-held calculator has had on arithmetic.

COMPUTER ALGEBRA PACKAGES

There are two significant properties exhibited by CA systems which elevate their usefulness beyond conventional numerical systems. First, there is no loss of arithmetic precision or significance because algebraic objects are represented exactly within the computer's store. Second, and perhaps more importantly from a teaching point of view, the input, output, and manipulation of algebraic objects takes place symbolically, that is, using normal algebraic notation. Many mathematicians are involved in extensive algebraic or non-numerical calculations in which straightforward but time consuming operations are involved before an error free and useful answer can be found. CA systems provide speedy, efficient and reliable sets of tools for performing long and tedious calculations symbolically. Until recently CA systems were available only to those with access to large and powerful computers. With the improved capabilities of microcomputers and improved algorithms such systems are accessible from any desktop.

The use of CA packages, once the domain of specialised research laboratories, is increasing. In research, participants are being made aware of this powerful tool which is being used not only in everyday problem solving and for tackling what were previously thought to be intractable problems (due to size or complexity). Education is about to benefit from the increasing availability of these systems on such microcomputers as PC-compatibles, the Apple Macintosh and the Atari ST. For example, both CP/M-80 and PC-DOS versions of the muMath package are available which provide facilities similar to older systems written for mainframe machines.

The capabilities of generalised CA packages include the following (in varying degrees of depth): polynomial manipulation; transcendental functions; equation solving; arbitrary precision arithmetic; substitution; differentiation; integration; matrix algebra; rule definition; procedures; program control; input/output and graphics.

There are several readily available general purpose CA packages. **REDUCE** is the oldest and most widely used system and has been implemented on a wide range of computers ranging in power from the IBM-PC to the Cray X-MP. **Maple** is a compact and powerful system well suited for multi-user systems. **muMath** was the first system designed for microcomputers and as such is a very compact system and has many of the features of the larger systems. **MACSYMA** is the largest and most powerful system. It requires 4Mb of virtual memory, is therefore only available for a restricted set of machines and is most useful for research work rather than teaching. **SMP** is a large and powerful system with restricted usage and is currently undergoing development. **SCRATCHPAD** is an IBM developmental project and should become available in the near future. An excellent review of these packages can be found in Harper et al(ref 1).

The lack of portable, cheap and user friendly systems is a criticism of all the above packages. They all cause a certain amount of difficulty for the naive user, and only **MACSYMA** and **SMP** produce graphical output. Two recently available packages provide graphical output and are expected to provide the major basis for educational use. They are **Derive**(ref 2) and **Mathematica**(ref 3). **Derive** is a successor to **muMath** and has a menu driven user-interface, on-line help, a 2-dimensional display of mathematical formulae, the capability of two- and three-dimensional plotting of functions, and a zoom facility. **Mathematica** is the most recent addition to the stable of CA packages and boasts impressive graphic facilities and a convenient and conceptually simple environment. It also contains a comprehensive list of mathematical constructs, but does so at the expense of being available only on the top range of microcomputers.

O.U. PROJECTS

As observed above, the major drawbacks to the majority of current computer algebra systems are: (i) the large amount of computer resources required for acceptable performance; (ii) the lack of attention paid to the user-interface; (iii) the knowledge required to use a package successfully.

In an attempt to obviate these difficulties our first project has embarked upon the construction of a *front-end* system(ref 4)–software with the objectives of: (i) providing a simple user-interface to a computer algebra system; (ii) giving easy to interpret output; (iii) being independent of any particular algebra system.

The front-end software views a computer algebra package as an *algebra engine* which provides the raw computing required to solve problems. The front-end is responsible for all user input and for displaying the output. It also enables the user to invoke complex sequences of actions through single commands, thereby enhancing the capabilities of a basic computer algebra package.

The front-end is specifically aimed at the novice user for the purpose of learning basic mathematics. It offers a very simple pull-down menu system together with suitable prompts for gathering input and displays results in a more "natural" way. The current state of the project is that a front-end has been implemented for muMath running on a variety of IBM XT compatible machines. The implementation is in Turbo Pascal. Our next step is to use the front-end system in the classroom where we shall be looking at the effectiveness of computer aided instruction using a computer algebra system, probably in the area of integration.

The second project has evolved from using **REDUCE** to develop a sophisticated model for investigating the properties of superconductor materials(ref 5). It is quite clear that **REDUCE** is not suitable for student use as it stands. This project has shown that, from a naive users point of view, the learning threshold for effectively making use of CA systems is relatively high but once overcome quickly repays the initial investment in effort. Also, because of their diverse nature, these general purpose packages provide excellent platforms for student investigations and project work. As the second project progressed it was soon apparent that there was a need for extensions to the **REDUCE** system to provide a more helpful system for tackling the superconductor problem. One way forward will be to provide pre-processing software which will derive the necessary **REDUCE** rules from the axioms of the original problem and hence generate an input text file for immediate **REDUCE** manipulation. This work confirms that, for educational use, a possible way forward is to provide comprehensive user-interfaces as front-ends to existing CA packages.

COMPUTER ALGEBRA IN EDUCATION

The Open University is interested in CA systems for teaching because its students learn on their own with little or no face-to-face tuition. Study of this form requires self discipline, hard work and can lead to a feeling of isolation on the part of the student. Mathematics education can be particularly trying under these circumstances, and this can be compounded by the forbidding notation and the requirement often to understand a line of argument based on following a series of steps each of which can provide a source of confusion if not executed correctly. The fact that we can now assume that students have readily available computing power allied with the potential use of a CA system will provide an improved basis for successfully encouraging the acquisition of mathematical knowledge and concepts at home. This will be an exciting extra innovation in the O.U.'s armoury of distance teaching techniques.

Of course, one would also expect this pedagogic style to be taken up by educational institutions with centrally based facilities. Indeed this pioneering experiment is already taking place in the UK, USA and elsewhere. A comprehensive bibliography is given in (ref 6).

The are several reasons for incorporating CA systems into mathematics teaching methodology. They save time (fast manipulation of algebra) and effort (remove boredom of repetitious manipulation), remove the need for tables of functions, series, and integrals, and use exact arithmetic to produce accurate answers with the option of floating point results. Finally, many CA packages can be enhanced by adding routines relevant to specific problems, and can act as a teaching aid in providing discovery learning via experimentation. However, we see the use of teaching packages as only a partial replacement of current pedagogic methodologies. Alone they will never be as good as a capable human tutor but can complement and enhance human tuition by, for example, allowing more time to be devoted to weaker students and providing a computer library of exercises. The OU is particularly interested in using this medium because of the inherent structured self-assessment and self-paced learning that can take place through graded exercises, and examples designed to highlight common errors.

TOWARDS THE FUTURE

Work is currently in hand at the OU to use CA systems in two futuristic ways. The first concerns the automatic construction of examination materials. There are numerous examples of educationalists solving past examination questions with the aid of algebraic packages, and this suggests that it may be possible to alleviate the tedious preparation, checking, and production of assessment materials by the automatic generation of future papers. This idea can be taken even further by setting up CA systems to check student attempts at CA generated materials, and then mark and grade the subsequent student scripts.

The second area of interest concerns more advanced use of CA teaching systems, known as explanation systems, in which students can browse and navigate within the system. That is, the student can proceed forward (tackle more difficult problems), move laterally (tackle problems at same level) or retrace steps (for revision or recap). There will be customised routes for various levels of expertise in which the teacher will set up different pathways appropriate to the student's background. There will also be the ability to react to the student's response, both through diagnostic information and by showing the consequences of pursuing a particular line of approach. The flexibility to change notation and methods of solution can also be foreseen.

CONCLUDING REMARKS

CA systems offer enormous possibilities. There seems an unlimited and tantalizing future for responsible use of these systems. We have just begun to see their potential, but we need to investigate in more depth what these packages offer the educationalist. We must decide how computer algebra packages should evolve for the benefit of education, and more effort needs to be put into designing better user-interfaces for specific teaching purposes. However, there is an urgent need for serious discussion about what should be taught in mathematics: these systems will have an even bigger impact on the teaching of mathematics than the simple calculator – we must heed the lessons that have been learned from the introduction of the calculator in schools.

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THE DEVELOPMENT AND IMPLEMENTATION OF A TELECOMMUNICATIONS SYSTM TO SUPPORT OUT-OF-SCHOOL ACADEMIC ACTIVITIES: A PROJECT REPORT

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ABSTRACT

With the increasing availability of easy-to-use telecommunications systems, conditions were right for a project to assist students in out-of-school academic activities through the use of such systems. In teaching mathematics at the middle school level, students are generally introduced to new problem types through classroom instruction, and then are asked to do a series of homework problems in which they are given practice in solving such problems. In this project, math help files were developed for each of these problem types, stored on a computer, and then were accessed by students using microcomputers with telecommunications capabilities. By such means, students were able to obtain help when doing the homework in out-of-school academic locations. The content of these same files was then installed on a computer-based answering machine, and students were given access using the home telephone as the terminal, and receiving the math help in an audio format.

INTRODUCTION

In mathematics instruction at the middle school, especially in pre-algebra courses, students are introduced to a variety of problem types and then provided extended practice in the solution of such problems. The typical approach has been for the instructor to introduce these problem types through lecture-oriented presentations, provide practice on the problems by having students work at the chalkboard or at their desks, and then give a homework assignment in which continued practice in solving such problems is offered. As long as the students are present at school, they all have equal access to help in solving the problems. But upon leaving the school building, the amount of help available greatly varies. In some homes, the parents are very willing to provide such help, and may even routinely check the homework papers of their children. In other homes, the parents may be very willing, but may not have had the experience necessary to provide the help. In some cases the students are then able to turn to older brothers and sisters who previously have taken the course and can thus provide help. But in many homes no such help is available, and in those settings the student may try seriously to solve the problem, but may be blocked by the lack of help. Such students then are forced to return to the class on the following day without having completed the required activities. It is for those students that the project has been designed, so they could always get help, regardless of the level of help available in their home.

OUTLINE OF PROJECT

Originally the project had three distinct phases, but as the project was conducted, a fourth phase was included which significantly extended the capabilities of the math help system. In the first phase the math help files were developed. These helps were designed on the basis of what a teacher would say to a student who requested assistance on any of the problem types in the math course. These helps were developed on a word processor and tested with the students. In addition, other math teachers were consulted for validation of these help messages.

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The second phase of the project consisted of the development of a BASIC program to be the interface between the student and the math help files. In the classroom where this project was initiated there were six Tandy Model 4 diskless workstations. These workstations were connected via a local area network to a Tandy Model 4, with a hard drive, which acted as the file server. The BASIC program was designed to request information from the student concerning the specific problem with which the student was having difficulty. This identification of the problem was by the number of the problem set and problem number within this set. With this information entered by the student, the BASIC program then displayed on the workstation screen a series of statements which were to help the student solve this type of problem. Thus the students, instead of raising their hands and waiting for the teacher to come to their desks, went directly to a workstation, obtained the teacher-generated help statements, and returned to their desks to complete the problem. The teacher then was freed to work individually with students whose difficulty extends beyond that which can be remedied by a series of help statements.

During the second phase of the project, the help statements were again evaluated, this time by the students themselves. Because the teacher had more free time in the classroom, it was possible to interview students who were using the help files and determine if the help statements were appropriate to their needs. Further, in the additional free time, the teacher was able to edit the existing help statements and create additional help statements.

The third phase of the project focused on providing access to the math help files through the use of telecommunications. In order for the students to be able to access the help files from their homes it was necessary to provide additional computing facilities and to make rather extensive program modifications. At the outset of the project it was felt that for that subset of students who were defined as being "at risk" a personal computer with a modem would be provided for use in their homes. It was felt that there were enough "first generation micros" available for providing these "loaners." In order to set up this phase it was necessary to obtain a copy of a Model 4 communications program called HOST/CMD to be installed on the Model 4 in the classroom and a program called TERM/CMD to be used by the student in the remote location. Using these programs, with modems installed on the machine at the school and the machines used in the homes, the students were able to access the math help files from their homes in the same manner that they had been doing in the classroom.

The fourth phase of the project, as previously stated, was designed at a time after the original three phases had been initiated. In the third phase in which remote access to the math help files was provided via modems and communications software, it was necessary to either use microcomputers which already existed in the homes, or to provide microcomputers for those students who had no access to such equipment in their homes. Since the basic focus of the project was on "at risk" students, and since most of these students were found not to have access to such equipment in their homes, many microcomputers were needed as loaners. However, an alternative was found, which became the basis for this fourth phase of the project.

Recently there have been introduced a number of computer-based telephone answering systems. Such systems use MS-DOS computers, such as the Tandy 1000, and serve the basic functions of cassette-based answering machines. But in addition to the functions provided by the standard answering machines, these computer-based answering machines provide a large variety of additional capabilities. Basic to many of these additional capabilities is a large number of "audio" mailboxes into which audio messages can be stored and retrieved. Such messages can be placed in the system either by the owner or by individuals wishing to speak with the owner. In addition, the owner can place messages in the audio mail boxes which can be "picked up" by other individuals accessing their mail boxes remotely. The particular system chosen for this project is called "BigMouth" and is produced by Talking Technology, Inc., located in Oakland, California.

In order to prepare the BigMouth system for use as a math help file server, certain software modifications were undertaken. In the standard BigMouth application, each mail box contains its own message. However, since each problem was classified as a certain problem type, and help was written for each problem type, many problems have the same help message. In order to reduce the disk space needed, and simplify the help files, an intermediate step was programmed which, given the problem set number and problem number, determined the problem type, and produced the appropriate help message. Also, since it was desired to have the students first be asked to enter the problem set number, and then the problem number, a program was developed to accept two separate inputs from the student. Normally, BigMouth is programmed to accept up to a five digit number, corresponding to the audio box number to be accessed. This change was made to two student inputs to make it easier for students to respond to the system. Thus the student, after making connection using a standard touch-tone telephone, will hear the welcome message, and then be asked to key in the problem set number, followed by pressing the key marked with the pound (#) sign. With the problem set number entered, the student will then hear a request for the problem number, again sending the request by pressing the pound sign. Upon receipt of these two inputs, the system locates the audio mail box containing the appropriate message and presents the information to the student. The student is able to have the message repeated in case it was not understood during the first presentation. Thus with the use of BigMouth, students are able to access math help using the standard touch tone telephones generally found in homes. For those "at risk" students who do not have such telephones, arrangements were being made to provide them with such a service.

FUTURE PROJECT ACTIVITIES

Several modifications to the math help system appear to be advantageous. First, it appears that there is a need for developing a second level of help files. That is, once a student has received the help for a specific problem, and is still not able to solve the problem, the second access for help to that same problem will retrieve a new set of statements which provide more detailed assistance for the solution. Further, it appears that it would be feasible to offer a third set of hints, and then, if the student still has difficulty in deriving the solution, provide the correct answer.

A second modification would include the changes necessary to provide the help in a language selected by the user. Thus, when the initial contact has been made via the telephone, the user would be asked to specify the language desired by responding with a "1" for Spanish, a "2" for Japanese, and so on throughout as many languages as it is desired to be available. The resulting messages would then all be given in the selected language.

A third modification will be the inclusion of help files for other subjects. Thus the student calling in would indicate the subject, and then indicate the specific area of difficulty. In such a modification, there is the possibility of very easily providing the help files in languages other than English.

A fourth modification is to include a section on school information. For example, school announcements could be placed in an audio mail box and could be accessed by any student. More specifically, assignment information could be placed in mail boxes for all subjects, so that students who, due to sickness, are unable to attend could obtain information concerning the assignments they may have missed.

The system could also be modified for use with attendance information. Because BigMouth has the capability of making calls and delivering pre-recorded messages, information concerning attendance could automatically be delivered to the home of the student. Recent reports of efforts in this area have indicated rather remarkable improvements in attendance through this sharing of information with the homes.

Finally, the system could be used to assist in instructional development. Because the capability to keep statistics concerning the number of accesses to any specific help file is built into the BigMouth system, teachers would be provided with objective measures concerning the success of students working independently on particular problems. It may be then that the teachers could use such information to guide in making changes in their class presentations such that students would have less and less difficulty with such problems. The ultimate goal of this instructional development process would be to reduce as much as possible the number of accesses to the help files, thus enabling the students to solve the homework problems with no other help than was provided in the classroom during the introduction to that particular problem set..

SUMMARY

It appears that computer systems of various sorts can be used to provide timely help to students engaged in out-of-school academic activities. The early phases of this project were devoted to the development and presentation of such help through the use of local area networks. An extension of this aspect was made by providing remote access to the same help files through the use of microcomputers with modems and telecommunications software. The most significant aspect of the project came through the inclusion of a computer-based telephone answering system by which students using standard touch-tone telephone equipment could access audio help files. Thus the "at risk" students are given the opportunity to obtain timely help, complete homework assignments, and return to the classroom better able to progress to other types of math problems. In addition, a number of other uses can be made of this telephone-based system, all of which are directed at increasing the effectiveness of teaching and learning.

PROJECT SPECIAL LINK: A Telecooperation Based Community Learning Environment Fostering Academic and Social Growth Among People At Home, School ,Hospital or Other Non-Traditional Learning Locations.

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Abstract

This paper will discuss a telecommunications project that is designed to provide an electronically bases human community made possible through computer based telecommunications by establishing links between hospitalized and homebound students with their local schools. Due to a wide range of medical conditions the students in the project are unable to regularly attend school. The project uses such technology as micro-workstations, a central data base and E-Mail system. FAX machines and scanners are also used to assist in student communication and the generation of data base content. The telecommunications software allows a wide range of communications.These include open and closed conferencing, chatting in real time and leaving E-Mail or BBS information on a delayed time basis. The system is designed to be operation all 365 days of the year and is not dependant on a given timetable or school semester structure.

As a result of advances in medicine, increased political awareness and legislation requiring equal opportunity for all students, students are now entering school systems with needs that many school systems, until recently, generally assumed they could not integrate into their programs. The notion of who has the right to a full and well rounded education and the ability of technology to provide delivery mechanisisms for educational programs, has forced many educational policy makers and planners to reconsider their positions. This is particularly the case with those groups of students who who cannot attend school on a regular basis.

Consequently, school Boards are faced with the challenge of providing equal opportunity access to educational services for such children. This is particularly challenging since in many cases these students cannot attend school in a traditional manner and for medical reasons are confined to their hospitals or homes. However, the power and flexibility inherent in telecommunications software and hardware equipment can allow these and other students to overcome many of the physical limitations imposed upon them by distance and medical conditions.

During 1987 The North York Board of Education in Ontario, Canada, through Ron Mason the Co-ordinator of Special Education, anticipated this need and responded by proposing a pilot project entitled Project Special LINK designed to link homebound students with a school in their community. The students are considered as members of specific classes within their schools. The telecommunications component of Project Special LINK allows scheduled interaction with teachers and classmates thus providing educational and social enrichment. An organizational framework for the policy, organization and operation of the pilot project was subsequently defined. The first stages of project implementation began during January 1988.

PROJECT SPECIAL LINK: A Telecooperation Based Community Learning Environment Fostering Academic and Social Growth Among People At Home, School ,Hospital or Other Non-Traditional Learning Locations.

Project Hardware and Software Organization

Users have two main telecommunication options. The first option involves a direct link from school to wherever the student is residing. For example, if the student is at home teachers and students can operate in the chat and mode and discuss the lesson content or issues that are currently taking place within the classroom. Chat mode allows real time discussion and interaction where questions can be asked and any content can be explained in detail as required. This mode can continue until the student at home has enough information to continue working on an independent basis. When this condition is met teachers and students in the classroom can then send files that can contain assignments or more information on the topic under discussion. The student at home need only leave the computer they are using in an answer mode and the files from the school are automatically transferred. Files can be sent at anytime to the home computer as long as the student at home remembers to leave it in the answer mode. The communications software being used also allows whoever sent the data from the school to catalogue the home computers directory to ensure that no errors have taken place in the transmission.

The second telecommunications option involves sending data via a third computer located in the school systems main library. The project has four dedicated telephone lines that allow users flexible access to the system. This central node is a Unisys ICON central fileserver with a dedicated memory of 70 M.B. It is on twenty-four hours each day seven days a week. The Iconet software program that runs this system has six powerful components. In order to use the system users are assigned passwords and E-Mail boxes. The entire Iconet program has six components:

Autoanswer: This program causes Iconet to switch communications parameters to match those of any incoming call from different types of computers and software.

Mail: Users on the system can send E-Mail messages to each other . Each time a person logs on the system checks for mail and automatically lists any that is waiting to be read. An interesting feature contained in the system is the a beep will go off if someone is trying to reach you if you are on the system talking to a second person, Iconet also informs each user when the mail they sent has been read.

Conference: Conferences can be open or closed, and may be held in real or delayed time.

Chat: This option allows for real time communication. It appears to foster small group interaction and expression. Many users who are otherwise intimidated with the telephone or face-to-face encounters enjoy the chat mode

Learn: This component allows subject specialists to develop interactive CAI programs that can be user for distance learning.

Utility: This option basic file manipulation where files can be sent to and received from other locations.

PROJECT SPECIAL LINK: A Telecooperation Based Community Learning Environment Fostering Academic and Social Growth Among People At Home, School ,Hospital or Other Non-Traditional Learning Locations.

Project Operation And Administrative Overview

Many large school boards have traditionally handled the needs of homebound students at home or in hospital by sending an itinerant teacher five hours a week. Our goal here has been to go beyond this and re-define the relationship the homebound student has with the school. Instead of accepting a representation that defines the student as physically and psychologically removed from the school, we have rejected this in favour of a model that believes student-school separation as a result of distance is irrelevant. Having done this we enhance the students self perception as a necessary daily participant within an identified grouping within a school. Where possible we have tried to provide leadership opportunities for those students working at a distance so that they gain extra status as a member of a school class.m It is also vital that the community be involved so that realistic educational approaches that would have transfer potential to *future* workplace settings. Further, a clearly defined need must be identified to justify the resource allocation necessary to staff and run projects like Special LINK. The evolution of this project for the first ten months of its operation was done on a volunteer basis. As a result of this it was determined that this form of telecommunication application was in fact cost-effective. Other insights that were gained were that it is critical to have partners from other areas of education such as psychological services. This form of support we now believe to be critical since many of the families with seriously ill children are often in crisis. In fact it is not an exaggeration to say that despite our reliance on technology it is **PEOPLE THAT MAKE THINGS HAPPEN through their creative application of technology.** Corporate sponsors were also included from the start. Eventually the project's potential was recognized and since Jan 88 it has began to grow.

Project operation takes place within policy and procedure, curricular and staff development frameworks. Two committees act as policy and procedure formulating bodies with a highly diversified composition representing political, curricular, business, administrative, parental, teaching and medical interests. These committees have a very practical orientation. For example, one of the business representatives from the Unisys corporation helped facilitate the hardware acquisition process. The committees are also organized to provide support in other areas such as curricular and staff development.

Operational management of the project is the responsibility of the project manager who serves on both the committees mentioned. Another important role within the project is that of case manager. Within each school a teacher has the role of a case manager for the student(s) at home or in hospital. The case manager organizes a team working with the parents, students and the project manager to define a communications schedule and curricular objectives designed in accordance with students available time. A critical component in this phase of the project is direct parental co-operation and participation in the working team. Once an agreement to establish a link has been arrived at and curricular objectives defined, the project manager designs an individualized training program to meet the often unique needs of each home/hospital school link. The training cycle, including hardware acquisition, on average, lasts between two and three weeks.

PROJECT SPECIAL LINK: A Telecooperation Based Community Learning Environment Fostering Academic and Social Growth Among People At Home, School ,Hospital or Other Non-Traditional Learning Locations.

Project Operation And Administration Overview.........*continued*

The progress of each location where the project is in operation is assessed on a regular basis to determine if the link established remains appropriate. It is projected that within the next five years that the number of potential candidates who will be able to make use of this type of educational service within the City of Toronto will be in excess of one hundred candidates.

An important aspect of Project Special LINK is the connection with Special Education. In Ontario ,Special Education is mandated by legislation with clear regulations regarding identification, placement , programming and review of student progress. By identifying student participating in Special LINK it provides safeguards for schools system and student alike. Review is ensured and objective decisions regarding the selection of students to be involved area made by an independent identification committee.

Future Directions

It is now clear that societies assuming the title of enlightened cannot ignore the needs each type of handicap presents in society when educational policy is being considered with the physically and often isolated people within their jurisdictions. Some pro-active strategies that would enhance the quality of programs delivery for homebound students that might be considered are a closer dialogue between hardware and assistive devices manufacturers.

Secondly a national data base could be designed that classified state of the art leading edge technology to assess if it had other unforeseen applications for such areas as PH or MH programs. Historically, it has been found that many technological innovations, particularly those of a military nature had great unforeseen potential to enhance the quality of human life as well as decrease its potential for survival. What is being suggested is not a naive swords to plowshares policy but a rational assessment of military and other technology to assess if we can re-represent and broaden the application base we have defined for these technologies . Remember, it was a businessman , not an educator that thought their might be money to be made by using large computers in 1948 to run business applications as well as calculate ballistic trajectories. Think about it.

Finally, please contact us if we can of any assistance in sharing further about the project as it develops.

Ron Mason

John Cameron

NEVER MIND THE TECHNOLOGY - FEEL THE NEED

David D Walker

ABSTRACT

This keynote address attempts to react to the potential mood of a conference audience having undergone four days of intensive technology debate. The paper suggests that, for a moment, we put aside purely technological issues and look at the needs of the users in our schools. There is a hint of what the actual address will tackle but essentially the final format and detail will be determined by the conference itself. A plea is made to co-operate in a meaningful and positive manner, ensuring that the work of the conference continues between annual conference dates.

THE FINAL KEYNOTE

I take this opportunity to express my gratitude for the honour the conference organisers have bestowed upon me - to present the final keynote - at least I think it is an honour! However, if you study the programme carefully you will see that alphabetically I am once again last. May this, therefore, be a tribute to all us long suffering W, X, Y and Zs of this world.

At the outset let me make it clear that this paper is a marker for the formal final keynote presentation. The actual presentation will be influenced by the submitted papers, the arguments, and the dialogue of the conference.

The purpose of a final keynote differs in the eyes of organisers, speakers and an audience. It is often a vehicle for pulling together the positive strains of the conference; for salvaging excellent ideas talked into oblivion; for keeping participants awake; for waving goodbye; for setting dates for next year; and for salving the consciences of those errant participants who missed presentations through their acquaintance with John Barleycorn or (my mentor) Johnny Walker. Allow me, however, to take this opportunity to set a positive course of action to support education and to identify activities that can be implemented immediately - activities which will, however, require us to give a real commitment to co-operation, more than mere words.

We should resist the temptation to be indulgent by identifying the principal audience today as being ourselves; rather we should concentrate on the real front line troops - pupils, teachers and parents. We should accept that a top-down approach starts at the very top - the pupils.

The Orlando conference will have given considerable attention to the technologies, according to the range of papers already submitted, so perhaps the time is appropriate to forget the technologies, for a short while, and concentrate on the needs of our principal audience. Let us **"forget technology and feel the need"**.

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I must remember to be both courteous and restrained, casting aside the habits of a lifetime! It has been my practice to talk at great length to educationists on issues of practical considerations including the financial and resource barriers which we, the simple wee souls dedicated to the needs of the children in our care, need to overcome in order to fulfil our caring objectives. Such talks usually involve a substantial armoury of criticisms aimed at civil servants, politicians and, of course, the computer industry. I will, however, try to be on my best behaviour and at least attempt not to miss anyone out.

The time is appropriate to put down markers for immediate action: markers regarding the role of the teaching profession; markers to identify what can sometimes be called barriers to learning. New technology itself should encourage the exchange of views and experiences but, if used incorrectly, may in itself raise such barriers. Above all, I want to emphasise my belief that computing - the new information technologies - is a 'co-operative science' active across many countries. If my belief is correct then I must ask "Why are we not doing more co-operative work and how can we correct this situation?"

EDUCATION BEFORE TECHNOLOGY

An educational strategy for any country cannot be based on technology alone. The rate of innovation in technology today remains two steps ahead of understanding. It is crucial that industry understands that the principal building blocks for educational computing development must be based on educational principles and that this understanding should be manifested through industrial corporate strategies.

We as educationists must also appreciate that the marketing strategies of computer manufacturers and suppliers are influenced by market forces. Although the technical and operational specifications of microcomputer systems for education are now beginning to polarise at various levels, purchasing decisions based on current configurations or price can easily be overturned by independent marketing policies. Systems should, therefore, be developed in accord with arguments based on educational needs and not wholly through market forces.

EDUCATIONAL PORTABILITY

Portability will be seen by educational administrators as being a major issue for a number of years to come. Let us not, however, at this stage, concentrate solely on technical portability. Let us take the opportunity to look at portability in its widest sense. After all, technical portability is possible and is practical - the problems lie with commercial strategy and interests.

The language of technology is itself often a barrier to understanding and learning. There is a need to develop a methodology to teach the new technology which does not rely on incomprehensible gibberish. Although most microcomputer systems are identified as "user-friendly" this term is often correct only when applied to a "micro-fool". To mere mortals the term user-friendly can be a misleading statement. The time is rapidly coming where a micro will be stated as the co-respondent in a divorce case - when the micro-fool brings the micro into the household all sense and reason evaporates to the detriment of loved ones. We should share the benefits of new technologies by making it available and attractive to all, discarding unnecessary jargon in favour of home-spun metaphors and anecdotes. (We may even begin to understand the technology better ourselves!). If experts can't agree on a comprehensible definition of a micro then we can accept that a micro is a micro if we can lift it.

Casting technology aside, for the moment, we should give consideration to the portability of experiences, the portability of ideas and the portability of design. Portability within an educational definition expects users to be computer mature, requiring them to feel confident in driving the technology rather than being submissive and allowing technology to drive them. I have often been asked if there is a point during a user's experience where significant changes of attitudes of perception take place. The answer is "Yes" and this tends to take place when a computer system poses the question "Answer: Yes or No". This marks the beginning of the user's control over the system. When the user feels competent to say "No" to a computer it gives them that necessary sense of authority and sense of real control over the system.

CURRICULAR AND THEMATIC CRITERIA

In trying to satisfy the needs of our clients we should ensure that software and courseware is developed in concert with curricular criteria. It is essential to establish development priorities in order to try to accommodate the demands and expectations of the teaching profession within a reasonable timescale. Once priorities have been identified then software should be developed through a thematic scenario. It is wrong to ask teachers to change their teaching strategy for one piece of software - however innovative it may be. Steps should be taken to ensure that between 15 and 20 computer assisted lessons, involving substantial non-computer support materials, be developed for each subject in any one year. We must give the teacher time to experiment with different teaching methods made available by the technology and to come to terms with a portfolio of new approaches.

PUPIL DIRECTION

Some administrators have expressed the fear that the power of computing in education is likely to encourage pupils to study areas of the curriculum to a depth not intended or, indeed, study subjects not initially intended to be within the curriculum. We should not fear the natural educational drive of our pupils: rather we should capitalise on their interest by designing the curriculum to be flexible. A further consequence of encouraging pupils to interrogate principles and other areas of interest outwith the curriculum is that it may be necessary to provide flexible examination systems.

RELEVANT HARDWARE

It is important when considering any form of training or teaching that the delivery system intended for the classroom is available. It is foolish to teach teachers, who are not themselves scientists or technologists, about issues regarding a generalised or "powerful system for the future". It is essential that teachers are taught on the delivery system about the delivery system and about the use of such a system in their own classroom environment.

TRAINING FOR ALL

New information technology is for all, but those of us of advanced years are somewhat at a disadvantage. Although it is normal to identify courses to teach teachers, technicians and programmers, it is essential to develop courses to teach those involved in education management. Key decision-makers in education must be the target for comprehensive training sessions. It is equally important to develop courses to teach parents, and to develop home learning systems where the parent is seen as sometimes tutor and sometimes co-learner.

WHY SOFTWARE EVALUATION?

The new technologies, however, must **not** be seen as raw materials for evaluators - rather food for thought for learners. I often speak against summative evaluation! Evaluation, to be of any real benefit, has to be supportive and adventurous. A great deal has been said, and will be said again and again, regarding the evaluation of software. If we are not careful we will lose sight of co-operative software development and the educational needs - giving way to pressures for an evaluation industry.

EEC SOFTWARE DEVELOPMENT

Through the EEC, we in the European Community have conducted two Summer Universities in an attempt to establish a mechanism for co-operation and a model for design portability. There are strong educational, technical and economic reasons for co-operation in Europe. No single member state has either the resources or the expertise to carry out the scale of research projects necessary to give the new technologies their proper place in their education environments. It was considered necessary to provide a framework for educationists to co-operate and exchange software models without the restrictions imposed by technology. In 1987 the EEC Summer University on Software Development was held in Glasgow under the auspices of SCET.

This software development laboratory was, in effect, spread over a two year period but concentrated the major coding exercise over a seven day period. Working groups had been set up in each of the member states of the EEC with the task of generating software design specifications and in July 1987 development teams from all the member states came to Glasgow where some 12,000 lines of coding were prepared.

It was during this phase that common design models and practical development tools were evaluated in an attempt to find the "Europeanness" of individual software specifications. Work on the Summer University continued for a further year after the intensive event in Glasgow and eventually produced some 13 pieces of software, made freely available throughout the member states, allowing for the first time identical pieces of software to be evaluated in each member state in its own mother tongue, giving the opportunity for each member state to assess and evaluate the use of a common set of programs in their schools.

EEC COMMON EDUCATIONAL CORE

This process of trying to determine the core co-operative element in software design across member states was carried a stage further at the

Summer University held in Paris in 1988 which was based upon the hypothesis that software design might be considered as a vector. Design groups in each of the member states were given the task of designing a software specification for a curricular application. The teams were asked to design the software specification without giving consideration to any specific piece of hardware.

The design groups were also encouraged not to be constrained by current levels of technology but to look further afield and give some expression of requirements for the future. At a later stage hardware constraints were then imposed through what was called the "Eurotopian microcomputer system" being somewhat of a futuristic hybrid of systems currently in use throughout Europe. Attempts were made to determine the position on this hypothetical vector where the original educational design had to be modified in light of the hardware technological constraints.

Further attempts were made to determine once more the position on this hypothetical vector where changes in the design would have to be imposed according to individual member states' curriculum or cultural needs. Naturally such a study gives rise to an attempt to determine a methodology in order that all member states can share, to the maximum degree, the design of educational software.

DESIGN WITHOUT INFLUENCE

It is very difficult, of course, to ask teams to design without being influenced by technology when technology and its effects have been a prominent feature in their daily teaching life. It was interesting to see the results of a similar experiment conducted with young school-children who had yet to formally experience the use of new technology in their classroom. The children were asked to design the school of the future and their views emphasised what can best be described as "body functions" where examples ranged from an obsession with school dinners to reinforced steel toilet doors! Technology was always featured as being the servant of the pupils. Examples included the powering of the school bus by dinner left-overs, technological punishment by electric shock and laser machines - referred to as capital punishment (assumed to be either a perceptual or spelling error). Robotic devices were seen to perform many of the functions currently undertaken by humans, including medical and dental checks, and there was also a squad of anti-cheating robots to supervise examinations. Robots were seen as more cost effective than human teachers as "robot teachers would even sweep the floors at nights". It was disturbing, however, to note that a significant number of children expressed the view that schools in the future would only be used by poor pupils who could not afford a technological teaching laboratory in their own home!

POSSIBLE TASKS

Perhaps we should carry out a more widespread Summer University exercise and, like the children, forget the technology and free our minds of such constraints. We may be able to see beyond the technology.

In a more immediate sense we could agree to work on the portability of ideas and specifications, each of us contributing one new idea or specification to be published as an ideas annexe to the conference proceedings.